Catchment Area Analysis of Forest Management and Market Trends:

Georgia Biomass
Fram Renewable Fuels

Prepared for:

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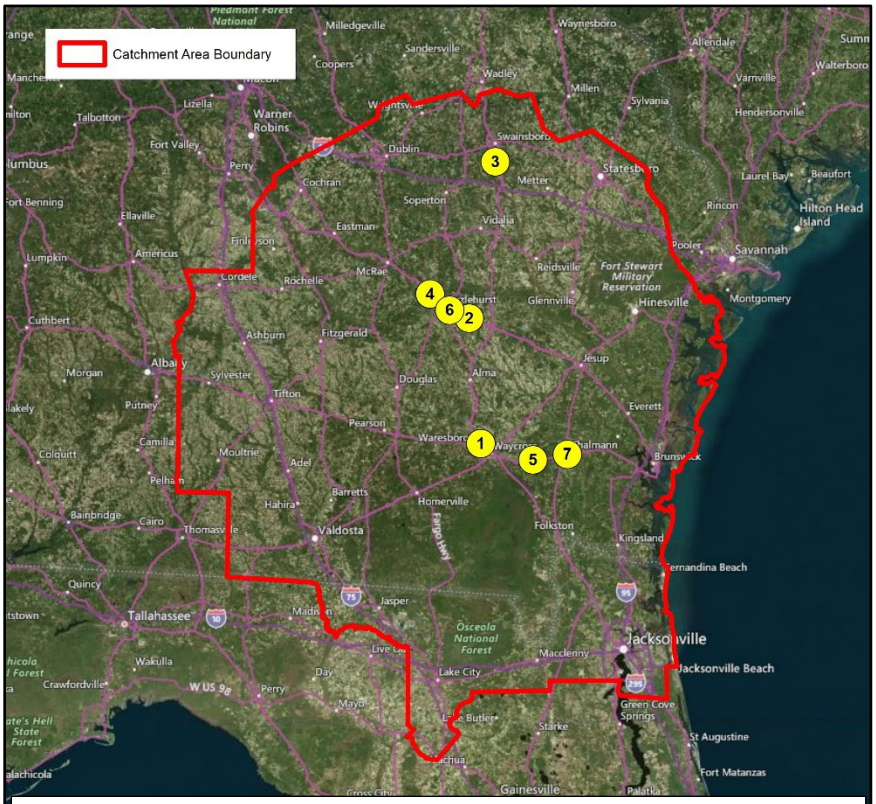
Executive Summary

In accordance with Drax's initiative to monitor forest management and timber market trends across its supply chain, the following report was conducted to examine the fiber catchment area in southeast Georgia and portions of northeast Florida that supports the Georgia Biomass and Fram Renewable Fuels' wood pellet mills (including two aggregate suppliers to Fram[1]). Specifically, the catchment area (denoted '*Georgia'* catchment area in this report) that supports these seven mills includes a combined 51 counties in Georgia and Florida and covers an area approximately 60,000 square kilometers in size (see Figure 1).

Combined production capacity of these seven pellet mills totals approximately 1.96 million metric tons of wood pellets annually. However, note that only Georgia Biomass, Hazlehurst Wood Pellets, and Archer Forest Products consume roundwood for pellet production. The remaining four mills utilize residuals only (i.e. sawmill residuals, shavings, and sawdust).

***Figure 1**. Georgia Catchment Area Boundary*



Mill Name	Location	Feedstock Type	Capacity (metric tons)	Startup
Georgia Biomass	Waycross GA	Roundwood + Residuals	750,000	2011
Appling County Pellets (Fram)	Baxley GA	Residuals Only	200,000	2008
LJR Forest Products	Swainsboro GA	Residuals Only	160,000	2014
Telfair Forest Products (Fram)	Lumber City GA	Residuals Only	120,000	2014
Varn Wood Products	Hoboken GA	Residuals Only	80,000	2012
Hazlehurst Wood Pellets (Fram)	Hazlehurst GA	Roundwood + Residuals	500,000	2014
Archer Forest Products (Fram)	Nahunta GA	Roundwood + Residuals	150,000	2015*

*Commissioned in 2015 as E-Pellets; shutdown in 2016; restarted by Fram Renewable Fuels in 2019

[1] Aggregate suppliers to Fram Renewable Fuels include LJR Forest Products and Varn Wood Products.

Forest Area, Timber Inventory, & Annual Wood Demand

Forest Area. According to US Forest Service data, the Georgia catchment area contains an estimated 4.2 million hectares of forestland, constituting approximately 70% of the catchment area's total land area. Specifically, 96% of total forestland (4.0 million hectares) is classified as timberland, or forestland that is capable of commercial timber production. Also note that 91% of total timberland is privately owned versus 9% public.

The total area of timberland held relatively steady through the 2000s and early 2010s, averaging roughly 4,111,000 hectares in the catchment area from 2000-2011. However, since 2011, timberland area has declined more than 115,800 hectares (-2.8%), falling to roughly 3,995,028 hectares in 2018, the latest available.

Timberland Area by Forest Type (2018)

Forest Type	Timberland Hectares	% of Total
Planted Pine	1,621,415	41%
Natural Pine	661,426	17%
Planted Hardwood	114,026	3%
Natural Hardwood	1,311,344	33%
Mixed Pine-Hardwood	286,817	7%
Total	3,995,028	100%

Inventory. Total growing stock inventory on timberland totaled an estimated 391 million m^3 in the Georgia catchment area in 2018, of which approximately 72% was softwood (pine) species and 28% was hardwood species. In terms of major timber product, approximately 34% of total growing stock inventory is classified as pine sawtimber, compared to 19% pine chip-n-saw, 19% pine pulpwood, 16% hardwood sawtimber, and 12% hardwood pulpwood.

Total timber inventory has steadily increased in the catchment area the last two decades, increasing an average of 1.0% per year (+19% total) from 328 million m^3 in 2000 to more than 391 million m^3 in 2018. Inventories of pine pulpwood – the predominant roundwood product consumed by the bioenergy industry – held between 80 and 90 million m^3 from 2000-2014. However, since 2014, pine pulpwood inventory has declined 10%, falling to less than 75 million m^3 in 2018.

Timber Inventory by Major Product (2018)

Timber Product	Inventory (000 m^3)	% of Total
Pine Sawtimber	132,724	34%
Pine Chip-n-saw	75,216	19%
Pine Pulpwood	74,939	19%
Hardwood Sawtimber	62,644	16%
Hardwood Pulpwood	45,809	12%
Total	391,331	100%

Wood Demand. As of July 2020, there were over 50 major wood-consuming mills operating within the Georgia catchment area, and an additional 80+ mills operating within close proximity to and that procure a portion of their wood from the catchment area. Altogether, total wood demand in the Georgia catchment area attributed to these mills was estimated at 23.6 million metric tons in 2019. Specifically, demand for pine and hardwood pulpwood – the roundwood products consumed by the bioenergy industry for wood pellet production – totaled a combined 11.7 million metric tons in 2019, or nearly 50% of total catchment area wood demand.

Of the 11.7 million metric tons of total pulpwood demand in the catchment area in 2019, approximately 87% was attributed to non-bioenergy-related sources (i.e. predominantly pulp/paper); 13% was attributed to the bioenergy sector. Bioenergy-related pulpwood demand totaled an estimated 1.6 million metric tons, of which approximately 87% was for softwood (pine) pulpwood and 13% was for hardwood pulpwood.

We'd like to make special note of the uniqueness of this market, particularly as it pertains to the pulp/paper industry and its impact on this catchment area. Specifically, there are eight pulp/paper mills located within 240 kilometers of one another along the Atlantic Coast between Savannah GA and Jacksonville FL, making this one of the most highly concentrated pulp/paper markets in not only the US South but also world-wide. Furthermore, an additional seven pulp/paper mills are located either inside or within 120 kilometers of this catchment area. Together, these 15 mills produce more than 7.8 million metric tons of pulp/paper annually and are responsible for roughly 45% of all wood demand placed on the Georgia catchment area.

Catchment Area Wood Demand by Major Product (2019)

Product	Demand (Metric Tons)	% of Total
Softwood Sawlogs	11,006,977	47%
Softwood Pulpwood	10,562,581	45%
Hardwood Sawlogs	886,531	4%
Hardwood Pulpwood	1,177,210	5%
Total	23,633,299	100%

Catchment Area Pulpwood Demand (2019)

Product	Demand (Metric Tons)	% of Total
Biomass Demand:		
Softwood Biomass	1,371,567	12%
Hardwood Biomass	200,865	2%
Biomass Total	1,572,432	13%
Other Pulpwood Demand:		
Other Softwood Pulpwood	9,191,015	78%
Other Hardwood Pulpwood	976,345	8%
Other Pulpwood Total	10,167,360	87%
Total Pulpwood Demand:		
Softwood Pulpwood	10,562,582	90%
Hardwood Pulpwood	1,177,210	10%
Pulpwood Total	11,739,792	100%

Summary of Analysis Findings

The following report provides a detailed assessment of the Georgia catchment area, including examination and identification of trends in forest area, timber inventory, growth, removals, wood demand, raw material prices, and harvest activities and management practices since 2000. In addition, this report also includes an assessment of long-term market sustainability and provides a market outlook through 2022.

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

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
Deforestation?	**No.** US Forest Service (USFS) data shows a 108,130-hectare (-2.6%) decrease in total timberland in the Georgia catchment area since Georgia Biomass' first full year of production in 2012. Specifically, this loss in total area of timberland coincided with a more than 21,000-hectare increase in cropland/pastureland and a more than 73,000-hectare increase in urban land and land classified as having other uses. However, there is little evidence to suggest that increased wood demand from the bioenergy sector has caused this decrease in total timberland. Furthermore, pine timberland – the primary source of roundwood utilized by the bioenergy industry – has increased more than 17,000 hectares in the catchment area since 2016.
A change in management practices (rotation lengths, thinnings, conversion from hardwood to pine)?	**No.** Changes in management practices have occurred in the catchment area over the last two decades. However, there is little evidence to suggest that bioenergy demand, which accounts for roughly 10-14% of total pulpwood demand (and only 5-7% of total wood demand in the catchment area), has caused or is responsible for these changes. Clearcuts and thinnings are the two major types of harvests that occur in this region, both of which are long-standing, widely used methods of harvesting timber. TimberMart-South (TMS) data shows that thinnings accounted for 67% of total reported harvest area in the southeast Georgia market from 2000-2010, but only 43% of total harvest area reported from 2012-2019. Specifically, this downward shift was initiated by the bursting of the US housing bubble in the mid-2000s and had been completed by the early 2010s. We'd like to note that this shift coincided with a nearly 50% decrease in pine sawtimber stumpage price from 2006-2012. This is important because the strength of pine sawtimber markets had been a driving force behind timber management decisions in this region in the early and mid-2000s. Also, contributing to the decreased prevalence of thinnings was the strengthening of pine pulpwood markets in the mid-2000s, as pine pulpwood stumpage prices increased more than 40% in the Georgia catchment area from 2003-2008. So, with sawtimber markets continuing to weaken and pulpwood markets doing just the opposite, the data suggests that many landowners decided to alter their management approach (to take advantage of strong pulpwood markets) and focus on short pulpwood rotations that typically do not utilize thinnings. Ultimately, the shift in management approach that occurred in this market can be linked to the weakening of one type of timber market and the strengthening of another. In the early and mid-2000s, timber management was focused on sawtimber production – a type of management that utilizes thinnings. However, for more than a decade now, this market has been driven to a large degree by the pulp/paper industry, with a significant portion of the timber management in this area focused on short pulpwood rotations.

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
Diversion from other markets?	**No.** Demand for softwood (pine) sawlogs increased an estimated 39% in the Georgia catchment area from 2011-2019. Also, increased bioenergy demand has caused no diversion from other pulpwood markets (i.e. pulp/paper), as pulpwood demand not attributed to bioenergy held steady and remained nearly unchanged from 2012-2017 before increasing in 2018 and 2019 due to the influx of salvage wood brought about by Hurricane Michael. We'd like to make special note that increased demand for softwood sawlogs since 2011 has not resulted in a full pine sawtimber (PST) stumpage price recovery in this market. Reduced demand for softwood sawlogs in the late 2000s and early 2010s resulted in oversupply, and this oversupply has remained, despite increased demand the last 6-8 years. As a result, PST stumpage prices have held steady and averaged roughly $30 per ton in the catchment area since 2013 – down approximately 35% from the 2000-2006 average of more than $46 per ton, but up roughly 15% from the 2011-2012 average of approximately $26 per ton.
An unexpected or abnormal increase in wood prices?	**No / Inconclusive.** The delivered price of pine pulpwood (PPW) – the primary roundwood product consumed by both Georgia Biomass and Fram – increased 26% in the Georgia catchment area over the six years directly following the startup of Georgia Biomass, increasing from $29.16 per ton in 2011 to $36.63 per ton in 2017. And while this 26% increase in delivered PPW price coincided with a roughly 1.1 million metric ton increase in annual pine pulpwood demand from Georgia Biomass and Fram, total demand for pine pulpwood (from both bioenergy and other sources) actually decreased 7% over this period. Moreover, evidence suggest that this increase in PPW price is more closely linked to changes in wood supply, specifically, the 9% decrease in PPW inventory from 2011-2017. However, there is evidence that links increased demand from the bioenergy sector to an increase in secondary residual (i.e. sawmill chips, sawdust, and shavings) prices. Specifically, the price of pine sawmill chips – a residual feedstock utilized by the bioenergy industry for wood pellet production – held steady and averaged approximately $26 per ton in the Georgia catchment area from 2008-2012. However, from 2012-2016, pine sawmill chip prices increased more than 15% (to $29.55 per ton in 2016). This increase in price coincided with annual pine residual feedstock purchases by Georgia Biomass and Fram increasing from roughly 325,000 metric tons to nearly 1.0 million metric tons over this period. However, note that pine sawmill chip prices have held steady and averaged roughly $29.50 per ton in the catchment area since 2016, despite further increases in pine secondary residual purchases by Georgia Biomass and Fram (to more than 1.2 million metric tons in 2019). Ultimately, the data suggests that any excess supply of pine secondary residuals in the catchment area was absorbed by the bioenergy sector in the early and mid-2010s, and the additional demand/competition placed on this market led to increased residual prices. However, the plateauing of residual prices since 2015 along with the continued increase in secondary residual purchases by Georgia Biomass and Fram further suggest that an increasing percentage of secondary residual purchases by the bioenergy sector is sourced from outside the catchment area. Specifically, Fram confirmed this notion, noting that 35-40% of its secondary residual purchases come from outside the Georgia catchment area (from six different states in the US South).
A reduction in growing stock timber?	**No.** Total growing stock inventory in the catchment area increased 11% from 2011 through 2018, the latest available. Specifically, over this period, inventories of pine sawtimber and chip-n-saw increased 35% and 13%, respectively. However, pine pulpwood inventory decreased 11% from 2011-2018.

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
	Note that the decrease in pine pulpwood inventory was not due to increased demand from bioenergy (or other sources) or increased harvesting above the sustainable yield capacity of the forest area – as annual growth of pine pulpwood has exceeded annual removals every year since 2011. Rather, this decrease can be linked to the 24% decline in pine sawtimber removals that occurred from 2005-2014 (due to the bursting of the US housing bubble and Great Recession that followed). In this region, timber is typically harvested via clearcut once it reaches maturity (i.e. sawtimber grade), after which the stand is reestablished, and the cycle repeated. However, with the reduced harvest levels during this period also came a reduction in newly reestablished timber stands – the source of pine pulpwood. So, with less replantings occurring during this period, inventories of pine pulpwood were not replenished to the same degree they had been previously, and therefore this catchment area saw a reduction in pine pulpwood inventory levels. However, according to the US Forest Service, annual removals of pine sawtimber have increased 50% in the Georgia catchment area since 2014, which would suggest higher clearcut levels and increased stand reestablishment. TimberMart-South data also supports this assertion, as clearcut harvests have constituted approximately 60% of the total harvest area reported to TimberMart-South in this region since 2014, compared to 40% from 2005-2014. Ultimately, these increases in clearcut (and stand reestablishment) levels may not be reflected in increased pine pulpwood inventory levels in the short term – as it can take more than 10 years for a pine seedling to become merchantable and reach the minimum diameter requirements to be classified as pulpwood. However, adequate supply levels are expected to remain in the meantime. Furthermore, pine pulpwood inventory levels are expected to increase in the mid-to-long terms as a result of the increased harvest levels and stand reestablishment levels that have occurred in the catchment area since 2014.
A reduction in the sequestration rate of carbon?	**No / Inconclusive.** US Forest Service data shows the average annual growth rate of total growing stock timber has remained nearly unchanged (holding between 6.0% and 6.1%) in the catchment area since 2011, which would suggest that the sequestration rate of carbon has also changed very little in the catchment area the last 8-10 years. However, the 11% increase in total growing stock inventory since 2011 does indicate that total carbon storage levels have increased in the Georgia catchment area since Georgia Biomass commenced operations in this market.
An increase in harvesting above the sustainable yield capacity of the forest area?	**No.** Growth-to-removals (G:R) ratios, which compare annual timber growth to annual harvests, provides a measure of market demand relative to supply as well as a gauge of market sustainability. In 2018, the latest available, the G:R ratio for pine pulpwood, the predominant timber product utilized by the bioenergy sector, equaled 1.06 (a value greater than 1.0 indicates sustainable harvest levels). Note, however, that the pine pulpwood G:R ratio averaged 1.44 from 2012-2017. The significant drop in 2018 was due to a 31% increase in removals (due to Hurricane Michael) and is not reflective of the new norm. Specifically, pine pulpwood removals are projected to be more in line with pre-2018 levels in 2019 and 2020, and so too is the pine pulpwood G:R ratio.

Impact of bioenergy demand on:	Analysis Findings
Timber growing stock inventory	**Neutral.** According to USFS data, inventories of pine pulpwood decreased 11% in the catchment area from 2011-2018. However, that decrease was not due to increased demand from bioenergy. Typically, a reduction in inventory is linked to harvest levels above the sustainable yield capacity of the forest area, but in this case, annual growth of pine pulpwood exceeded annual removals every year during this period. Ultimately, the decrease in pine pulpwood inventory from 2011-2018 can be linked to decreased pine sawtimber production beginning in the mid-2000s. Specifically, annual removals of pine sawtimber decreased 24% from 2005-2014, and the reduction in harvest levels during this period meant fewer new pine stands were reestablished, and that has led to the current reduction in pine pulpwood inventory. (Note that the decrease in pine sawtimber removals from 2005-2014 was mirrored by a 27% increase in pine sawtimber inventory over this same period). However, USFS data shows that annual removals of pine sawtimber have increased 50% in the Georgia catchment area since 2014, which suggests that pine pulpwood inventory levels will start to increase in the catchment area due to increased harvest levels and the subsequent increase in stand reestablishment levels.
Timber growth rates	**Neutral.** Timber growth rates have increased for both pine sawtimber and pine chip-n-saw but decreased slightly for pine pulpwood in the catchment area since 2011. Evidence suggests that this decrease in pine pulpwood growth rate is not due to increases in bioenergy demand, but rather linked to changes in diameter class distribution and indicative of a forest in a state of transition, where timber is moving up in product class (i.e. pine pulpwood is moving up in classification to pine chip-n-saw).
Forest area	**Neutral.** In the Georgia catchment area, total forest area (timberland) decreased more than 115,000 hectares (-2.8%) from 2011 through 2018. Note that this decrease coincided with a roughly 19,000-hectare increase in cropland and 93,000-hectare increase in urban land and land classified as having other uses. Specifically, pine timberland, the primary source of roundwood utilized by the bioenergy industry, decreased over 34,000 hectares from 2011-2016. However, from 2016-2018, pine timberland stabilized and rather increased more than 17,000 hectares in the catchment area (or a net decrease of roughly 17,000 hectares from 2011-2018). Ultimately, there is little evidence that the decrease in pine timberland from 2011-2016 or increase since 2016 is linked to increased bioenergy demand. Rather, the overall decrease in pine timberland since 2011 appears to be more closely linked to the relative weakness of pine sawtimber markets in the Georgia catchment area and the lack of return from sawtimber.
Wood prices	**Positive / Negative.** Intuitively, an increase in demand should result in an increase in price, and this is what the data shows in the Georgia catchment area as it relates to increased biomass demand from Georgia Biomass and Fram and the prices of the various raw materials consumed by these mills. Specifically, the 1.4-million metric ton increase in softwood pulpwood demand attributed to Georgia Biomass and Fram coincided with a 20% increase in delivered pine pulpwood price and a 10-15% increase in pine chip prices from 2011-2015. Since 2015, biomass demand has held relatively steady, and, overall, so too have delivered pine pulpwood and pine chip prices. The apparent link between increased bioenergy demand and increased pine raw material prices is supported further by statistical analysis, as strong positive correlations were found between softwood biomass demand and both delivered pine pulpwood and pine chip prices. However, note that biomass demand alone is not responsible for these changes in prices, as softwood biomass demand accounts for only 10-15% of total softwood pulpwood demand in the catchment area. Rather, the prices of these raw materials are impacted to a larger

	degree by demand from other sources (i.e. pulp/paper), which accounts for 85-90% of total softwood pulpwood demand in the Georgia catchment area. On the other hand, it's also important to note that the increase in bioenergy-related wood demand has been a positive for forest landowners in the Georgia catchment area. Not only has bioenergy provided an additional outlet for pulpwood in this market, but the increase in pulpwood prices as a result of increased pulpwood demand has transferred through to landowners (improved compensation). Specifically, since 2015, pine pulpwood (PPW) stumpage price – the price paid to landowners – has averaged more than $17 per ton in the Georgia catchment area. This represents a 70% increase over the approximately $10 per ton averaged by PPW stumpage in the catchment area over the five years prior to Georgia Biomass' startup in 2Q 2011. (Note: Pine pulpwood stumpage prices are notably higher in the Georgia catchment area due to a much tighter balance in supply and demand (in comparison to most other markets across the US South). For instance, in all other areas across the US South[2], PPW stumpage prices have averaged less than $9 per ton since 2015, or roughly half that of prices in the Georgia catchment area).
Markets for solid wood products	**Positive.** In the Georgia catchment area, demand for softwood sawlogs used to produce lumber and other solid wood products increased an estimated 39% from 2011-2019, and by-products of the sawmilling process are sawmill residuals – materials utilized by Georgia Biomass and the Fram mills to produce wood pellets. With the increased production of softwood lumber, so too has come an increase in sawmill residuals, some of which have been purchased/consumed by Georgia Biomass and Fram. Not only have these pellet producers benefited from the greater availability of this by-product, but lumber producers have also benefited, as the Georgia Biomass and Fram mills have provided an additional outlet for these producers and their by-products.

[2] The US South includes Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia. According to TimberMart-South, pine pulpwood stumpage prices have averaged $8.83 per ton across the South, excluding Florida and Georgia (the two states in which the Georgia catchment area is located), since 2015.

1. Report Background

Drax Group is a British electrical power generation and supply company that runs Europe's biggest biomass-fueled power station, supplying between 7-8% of the country's electricity needs. Drax is also among the world's largest single-point consumers of wood and is committed to sourcing that wood responsibly.

In accordance with Drax's initiative to monitor forest management and timber market trends across its supply chain, the following report, conducted by Hood Consulting, focuses specifically on the fiber catchment area in southeast Georgia and portions of northeast Florida that supports Georgia Biomass and Fram Renewable Fuels' four pellet mills (including two additional pellet mills that serve as aggregate suppliers to Fram). Specifically, this catchment area analysis examines and identifies trends with timber inventory, growth, removals, wood demand, raw material prices, and harvest activities and practices in the southeast Georgia catchment area since 2000. It also includes an assessment of long-term market sustainability and provides a market outlook through 2022.

The seven mills for which this catchment area is defined have a combined production capacity of approximately 1.96 million metric tons of wood pellets annually, with total roundwood demand totaling between 1.5 and 1.7 million metric tons annually. Mill details include:

- Georgia Biomass is located in Waycross, Georgia, and commenced pellet production in April 2011. The Georgia Biomass mill is among the largest facilities of its kind in the world, with an annual production capacity of approximately 750,000 metric tons of wood pellets.
- Appling County Pellets, the wholly owned subsidiary of Fram Renewable Fuels, is located in Baxley, Georgia, and commenced pellet production in March 2008. The facility utilizes both softwood and hardwood feedstock and has an annual production capacity of 200,000 metric tons of wood pellets.
- Hazlehurst Wood Pellets, the wholly owned subsidiary of Fram Renewable Fuels, is located in Hazlehurst, Georgia and commenced pellet production in January 2014. The facility utilizes softwood feedstock and has a production capacity of 500,000 metric tons of wood pellets per year.
- Telfair Forest Products, a subsidiary of Fram Renewable Fuels, is located in Lumber City, Georgia, and commenced pellet production in February 2014. The mill has a production capacity of 120,000 metric tons of wood pellets per year.
- Archer Forest Products, a division of Fram Renewable Fuels, is located in Nahunta, Georgia, and has an annual production capacity of 150,000 metric tons of wood pellets. The mill, originally commissioned by E-Pellets in 2015, was shut down in March 2016 but restarted by Fram in January 2019.
- Varn Wood Products, an aggregate supplier of Fram Renewable Fuels, is located in Hoboken, Georgia, and has a production capacity of 80,000 metric tons of wood pellets per year. The plant, which commenced pellet production in 2012, utilizes wood residuals from Varn's pine sawmill for pellet production.
- LJR Forest Products, an aggregate supplier of Fram Renewable Fuels, is located in Swainsboro, Georgia, and commenced pellet production in 2014. Annual production capacity totals approximately 160,000 metric tons of wood pellets.

1.1 About Hood Consulting

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

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

2. Defined Catchment Area

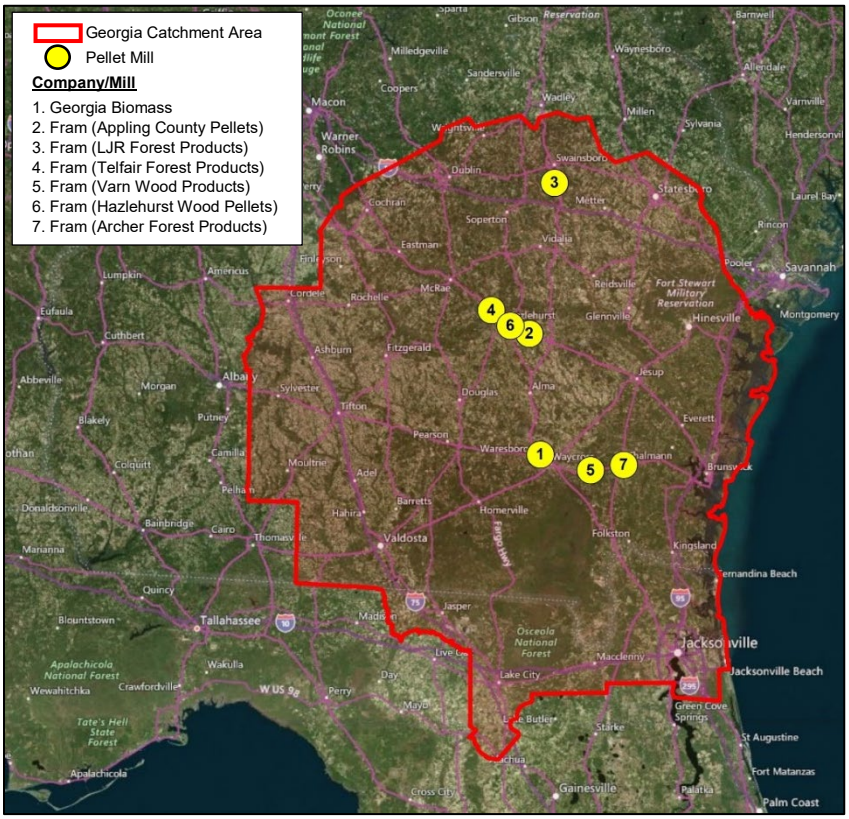
A mill's catchment area is the area in which a single pellet mill ("nucleus mill") has directly acquired fiber since the mill started operations, including any additional forest areas where future purchase contracts exist. However, given the proximity of the Georgia Biomass and Fram pellets mills, the catchment areas of these mills largely overlap one another and can be combined to form one single catchment area.

Catchment Area Boundary

The combined catchment area for Georgia Biomass and Fram (denoted 'Georgia' catchment area hereafter) was identified based on historic wood purchases data provided by these two companies. Specifically, this area includes a combined 51 counties in Georgia and Florida and covers an area approximately 23,000 square miles (≈14.8 million acres) in size. It extends from beyond Swainsboro GA in the north to Lake City FL in the south, and from the Atlantic Coast to the east (from roughly Savannah GA to Jacksonville FL) to Albany GA in the west.

Note that all roundwood purchased by Georgia Biomass[3] and nearly 100% of Fram's historic roundwood purchases have come from within the defined catchment area. The exception for Fram includes roughly 4,500 tons of roundwood purchased by Hazlehurst Wood Pellets in the following Georgia counties: Burke, Chatham, Crawford, Houston, Jones, Macon, Twiggs, and Wilkinson.

***Figure 2**. Defined Georgia Catchment Area*



[3] Exception includes salvage wood purchased by Georgia Biomass outside the defined catchment area in 2018 following Hurricane Michael.

***Table 1**. Georgia Catchment Area – County List*

State	County	State	County
FL	Baker	GA	Evans
FL	Columbia	GA	Glynn
FL	Duval	GA	Irwin
FL	Hamilton	GA	Jeff Davis
FL	Nassau	GA	Johnson
GA	Appling	GA	Lanier
GA	Atkinson	GA	Laurens
GA	Bacon	GA	Liberty
GA	Ben Hill	GA	Long
GA	Berrien	GA	Lowndes
GA	Bleckley	GA	McIntosh
GA	Brantley	GA	Montgomery
GA	Brooks	GA	Pierce
GA	Bryan	GA	Pulaski
GA	Bulloch	GA	Tattnall
GA	Camden	GA	Telfair
GA	Candler	GA	Tift
GA	Charlton	GA	Toombs
GA	Clinch	GA	Treutlen
GA	Coffee	GA	Turner
GA	Colquitt	GA	Ware
GA	Cook	GA	Wayne
GA	Crisp	GA	Wheeler
GA	Dodge	GA	Wilcox
GA	Echols	GA	Worth
GA	Emanuel		

3. Market Profile & Resource Assessment

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

3.1 Land Area & Use

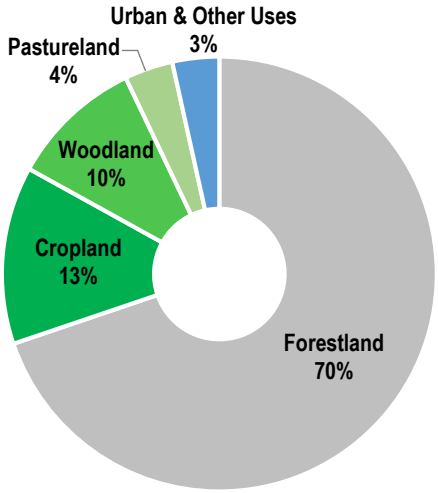
According to the US Department of Agriculture (USDA), the Georgia catchment area totals approximately 5,961,143 hectares in size. Approximately 70% (4,161,035 hectares) of the total land area is classified as forestland, 27% (1,592,482 hectares) is farmland, and 3% (207,627 hectares) is urban areas or land that is classified as having other uses.

***Table 2**. Georgia Catchment Area - Land Area by Land Classification & Use (2018)*

Land Classification / Use	Hectares	% of Total
Forestland	4,161,035	70%
Farmland:		
Cropland	788,904	13%
Woodland	588,720	10%
Pastureland	214,857	4%
Total Farmland	1,592,482	27%
Urban & Other Uses	207,627	3%
Total	**5,961,143**	**100%**

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

***Figure 3**. Georgia Catchment Area – Land Area Distribution by Land Classification & Use (2018)*



3.1.1 *Forestland*

Forestland, defined by the USDA as land at least 10% stock with trees of any kind, totals approximately 4,161,035 hectares and constitutes 70% of the catchment area's total land area.

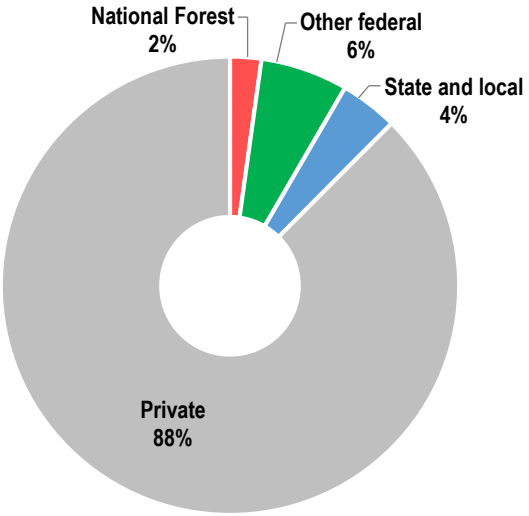
Ownership of forestland in the Georgia catchment area is predominantly privately owned. According to US Forest Service - Forest Inventory and Analysis (FIA) data from 2018, the latest available, privately-owned forestland constitutes 88% of total forestland and totals approximately 3,635,703 hectares. Public forestland constitutes 12% of total forestland in the catchment area, with National Forests totaling 95,352 hectares (2%), other federal forestland totaling 257,439 hectares (6%), and forestland owned by state and local authorities totaling 172,541 hectares (4%).

***Table 3**. Georgia Catchment Area - Forestland Area by Ownership Group (2018)*

Ownership Group	Hectares	% of Total
National Forest	95,352	2%
Other Federal	257,439	6%
State and Local	172,541	4%
Private	3,635,703	88%
Total	**4,161,035**	**100%**

Source: USDA – US Forest Service

***Figure 4**. Georgia Catchment Area - Distribution of Forestland Area by Ownership Group (2018)*



3.1.1.1 *Timberland*

Not all forestland is capable of commercial timber production. However, the USDA provides an alternative designation for forestland that can be commercially productive. Timberland is defined by the USDA as forestland that is capable of producing at least 20 ft^3 of industrial wood per year.

In the Georgia catchment area, timberland constitutes 96% of total forestland and totals approximately 3,995,028 hectares. *Note that this report will focus specifically on timberland, and all data provided hereafter regarding timber inventory, growth, and removals will be from timberland only.*

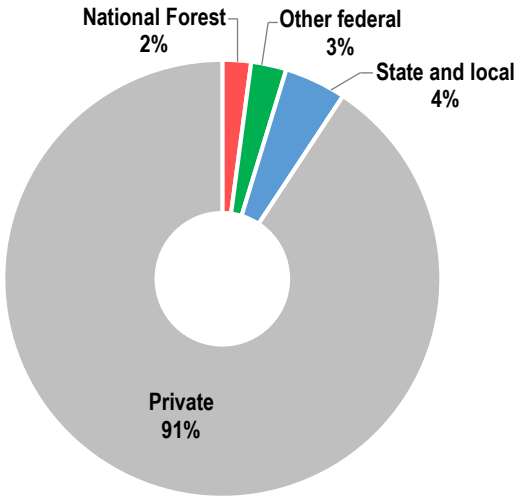
Ownership of timberland in the Georgia catchment area is similar to that of forestland, with 91% (3,633,281 hectares) of total timberland privately owned, compared to 2% (94,319 hectares) National Forests, 3% (109,293 hectares) other federal, and 4% (158,135 hectares) owned by state and local authorities.

***Table 4**. Georgia Catchment Area - Timberland Area by Ownership Group (2018)*

Ownership Group	Hectares	% of Total
National Forest	94,319	2%
Other Federal	109,293	3%
State and Local	158,135	4%
Private	3,633,281	91%
Total	**3,995,028**	**100%**

Source: USDA – US Forest Service

***Figure 5**. Georgia Catchment Area - Distribution of Timberland Area by Ownership Group (2018)*



Age Class Distribution

According to US Forest Service data, of the 3,995,028 hectares of timberland in the catchment area, approximately 55% (2,199,636 hectares) is classified as softwood timberland, 36% (1,440,687 hectares) is classified as hardwood timberland, and 9% (354,704 hectares) is classified as mixed pine-hardwood timberland.

Distribution of timberland area by age class varies by forest type. Specifically, 79% of softwood timberland is 35 years of age or younger, with the average age of softwood timberland estimated at 25.3 years of age. The distribution of hardwood timberland by age class shows approximately 64% is 50 years of age or younger. However, 19% of hardwood timberland area is five years of age or younger. This value likely includes transitional stands and those with low stocking levels that will likely not reach maturity. Excluding this youngest age class, approximately 84% of the remaining hardwood timberland area is 6-75 years old, with the average age of hardwood timberland estimated at 45.8 years of age.

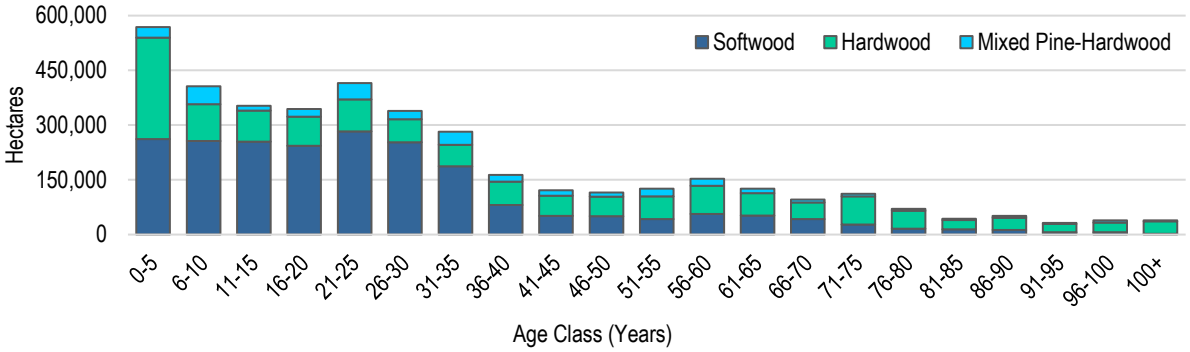
The distribution of mixed pine-hardwood timberland shows 61% is 35 years of age or younger, with 85% 60 years of age or younger (average age estimated at 33.8 years old).

***Table 5**. Georgia Catchment Area - Distribution of Timberland Area by Age Class & Forest Type (2018)*

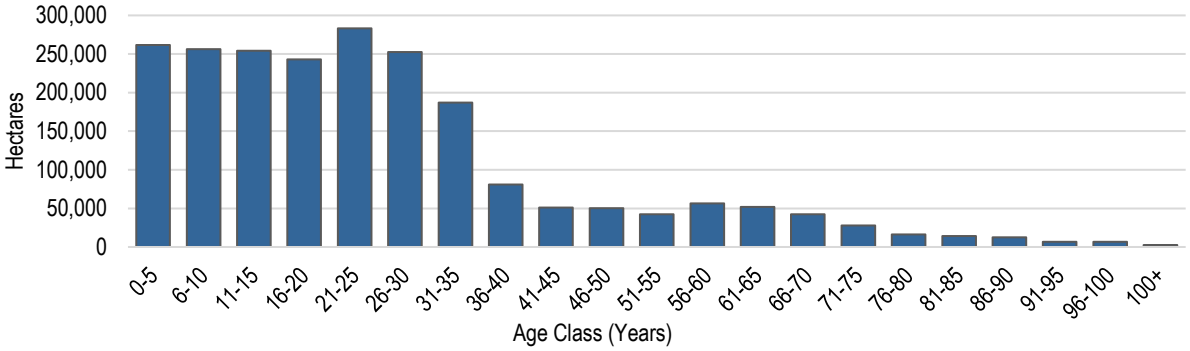
Age Class (Years)	*Softwood*		*Hardwood*		*Mixed Pine-Hardwood*		*Total*	
	Hectares	Distribution	Hectares	Distribution	Hectares	Distribution	Hectares	Distribution
0-5	261,542	12%	278,351	19%	28,558	8%	568,452	14%
6-10	256,136	12%	100,887	7%	49,598	14%	406,621	10%
11-15	254,309	12%	85,305	6%	13,246	4%	352,860	9%
16-20	243,121	11%	79,611	6%	21,038	6%	343,770	9%
21-25	283,111	13%	86,934	6%	45,480	13%	415,525	10%
26-30	252,551	11%	63,244	4%	22,652	6%	338,447	8%
31-35	187,185	9%	59,070	4%	35,564	10%	281,819	7%
36-40	80,882	4%	63,940	4%	18,933	5%	163,755	4%
41-45	51,224	2%	55,433	4%	14,426	4%	121,083	3%
46-50	50,058	2%	54,174	4%	11,434	3%	115,666	3%
51-55	42,220	2%	62,721	4%	21,116	6%	126,056	3%
56-60	56,353	3%	77,404	5%	19,321	5%	153,077	4%
61-65	51,744	2%	61,528	4%	12,295	3%	125,567	3%
66-70	42,375	2%	45,714	3%	8,216	2%	96,306	2%
71-75	27,702	1%	76,684	5%	7,203	2%	111,589	3%
76-80	16,421	1%	49,068	3%	5,304	1%	70,793	2%
81-85	14,347	1%	25,319	2%	3,641	1%	43,307	1%
86-90	12,495	1%	33,410	2%	5,004	1%	50,909	1%
91-95	6,694	0%	22,335	2%	2,518	1%	31,546	1%
96-100	6,723	0%	25,715	2%	6,211	2%	38,648	1%
100+	2,442	0%	33,843	2%	2,947	1%	39,233	1%
Total	**2,199,636**	**100%**	**1,440,687**	**100%**	**354,704**	**100%**	**3,995,028**	**100%**

Source: USDA - US Forest Service

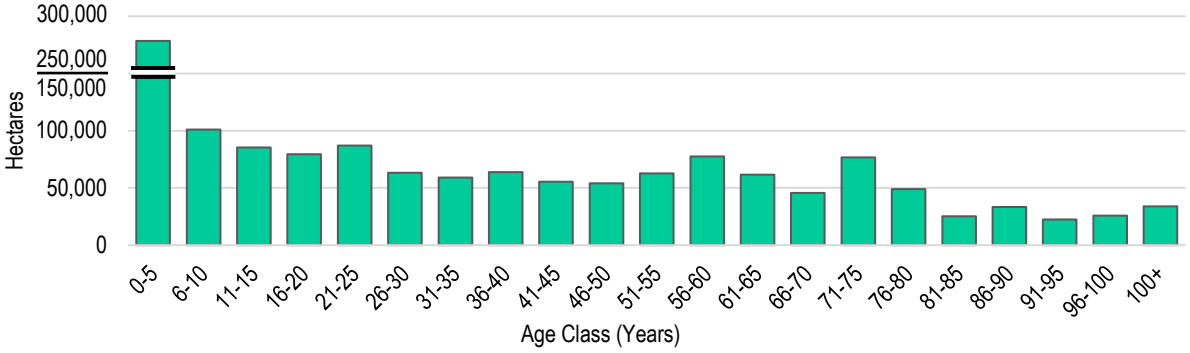
***Figure 6**. Georgia Catchment Area - Distribution of Timberland Area by Age Class & Forest Type (2018)*



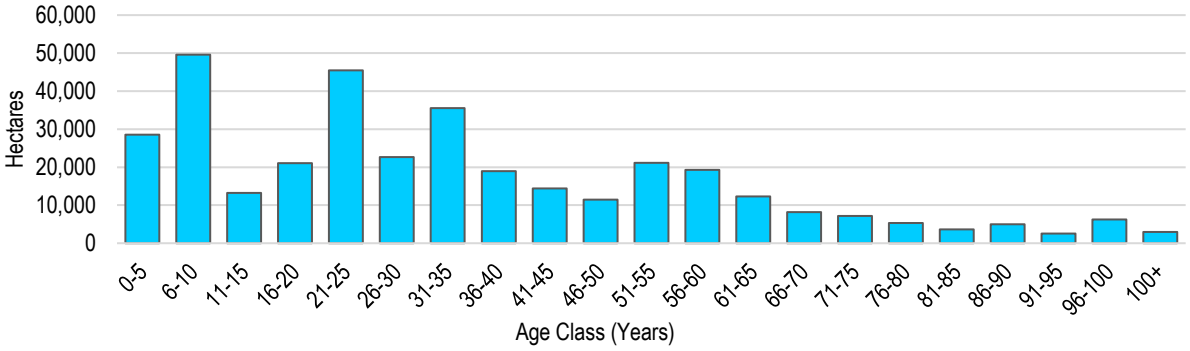
(a) Total Timberland



(b) Softwood Timberland



(c) Hardwood Timberland



(d) Mixed Pine-Hardwood Timberland

Stand Origin

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

According to the most current USFS estimates, approximately 57% (2,259,587 hectares) of total catchment area timberland is classified as naturally regenerated forests, compared to 43% (1,735,440 hectares) planted forests. However, distribution of timberland area by stand origin varies widely by major forest type.

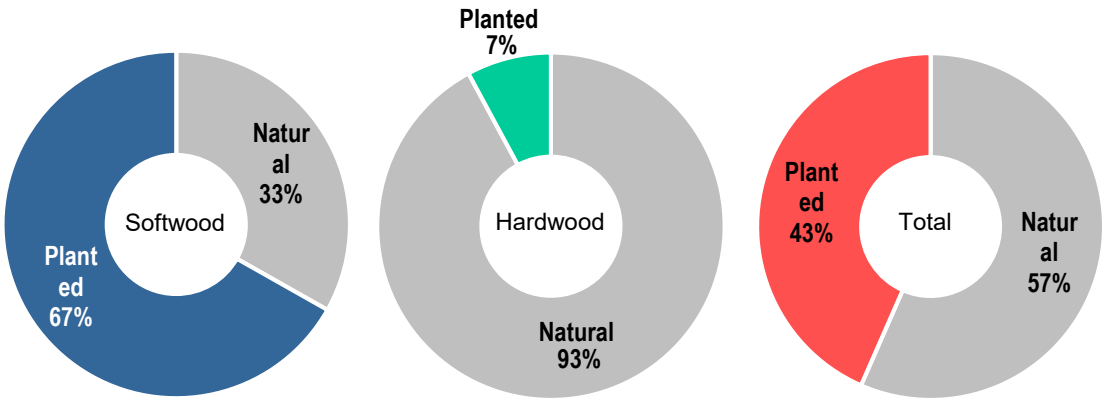
US Forest Service data shows 33% (804,835 hectares) of softwood timberland is naturally regenerated versus 67% (1,621,415 hectares) planted. In contrast, 93% (1,454,753 hectares) of hardwood timberland is naturally regenerated, compared to 7% (114,026 hectares) planted.

***Table 6**. Georgia Catchment Area - Timberland Area by Stand Origin & Major Forest Type (2018)*

	Softwood		*Hardwood*		*Total*	
Stand Origin	**Hectares**	**Distribution**	**Hectares**	**Distribution**	**Hectares**	**Distribution**
Naturally Regenerated	804,835	33%	1,454,753	93%	2,259,587	57%
Planted	1,621,415	67%	114,026	7%	1,735,440	43%
Total	**2,426,249**	**100%**	**1,568,779**	**100%**	**3,995,028**	**100%**

Source: USDA - US Forest Service

***Figure 7**. Georgia Catchment Area - Distribution of Timberland Area by Stand Origin & Major Forest Type (2018)*



3.2 Timber Inventory

Timber inventory data for the Georgia catchment area is provided by the US Forest Service - Forest Inventory & Analysis (FIA) program. FIA data utilizes approximately 50-60 sample plots per county to calculate inventory estimates, with sampling errors of 10-25%.

Note that this section profiles timber inventory, growth, and removal details as of 2018[4], the most current available. Further analysis, including inventory trends since 2000 and projections through 2022, is provided in the *Market Trends, Analysis, & Outlook* section beginning on page 54.

3.2.1 *Ownership Group*

Growing stock inventory on timberland in the Georgia catchment area in 2018, the latest available, totaled an estimated 391 million m^3, of which approximately 87% (342 million m^3) is privately owned, 5% (19 million m^3) is owned by other federal authorities, 5% (18 million m^3) is owned by state and local authorities, and 3% (12 million m^3) is National Forest.

Note that the distributions of both softwood and hardwood growing stock inventory by ownership group are nearly identical to that of total growing stock inventory. See Table 7 for details.

***Table 7**. Georgia Catchment Area - Growing Stock Volume on Timberland by Ownership Group and Major Species (2018)*

Ownership Group	Softwood Inventory	Hardwood Inventory	Total Inventory
		(000 Cubic Meters)	
National Forest	9,920	1,867	11,787
Other Federal	14,288	4,948	19,236
State and Local	14,445	3,793	18,238
Private	244,433	97,637	342,070
Total	**283,087**	**108,244**	**391,331**

Source: USDA - US Forest Service

[4] US Forest Service-FIA data for those counties located in Florida were only available through 2017. Estimates for 2018 have been included and are based on historical trends and a local area inventory model.

3.2.2 *Diameter Class Distribution*

Distribution of total growing stock inventory on timberland by diameter class varies by major species group. Based on the most current US Forest Service estimates, approximately 83% (236 million m^3) of total softwood growing stock inventory is 5- 17 inches in diameter, with 96% (272 million m^3) less than 23 inches in diameter. In comparison, 71% (77 million m^3) of total hardwood growing stock inventory is 5- 17 inches in diameter, with 91% (98 million m^3) less than 23 inches in diameter.

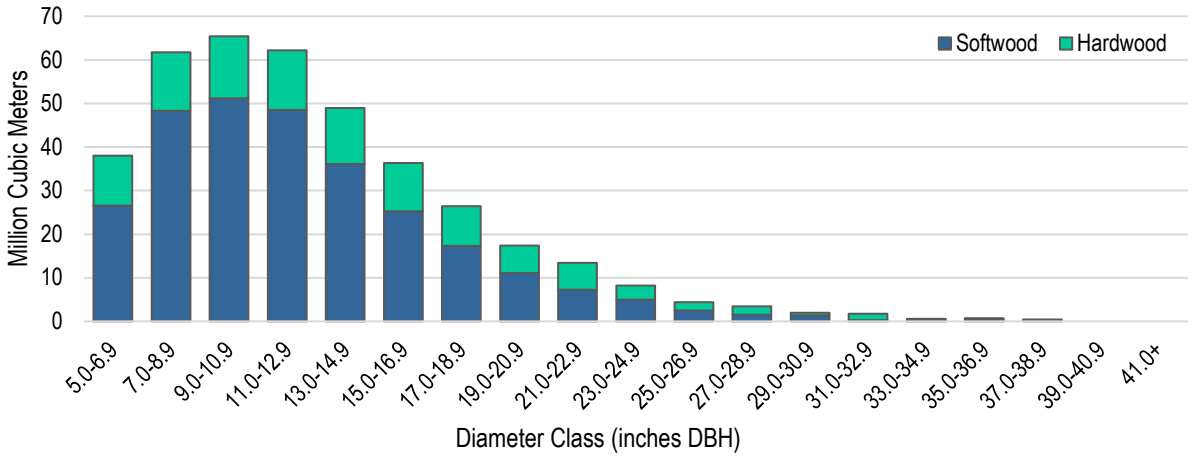
Based on these diameter class distributions, softwood growing stock inventory averages an estimated 12.5 inches in diameter, compared to 14.3 inches for hardwood growing stock inventory.

***Table 8**. Georgia Catchment Area - Timber Inventory by Major Species Group & Diameter Class (2018)*

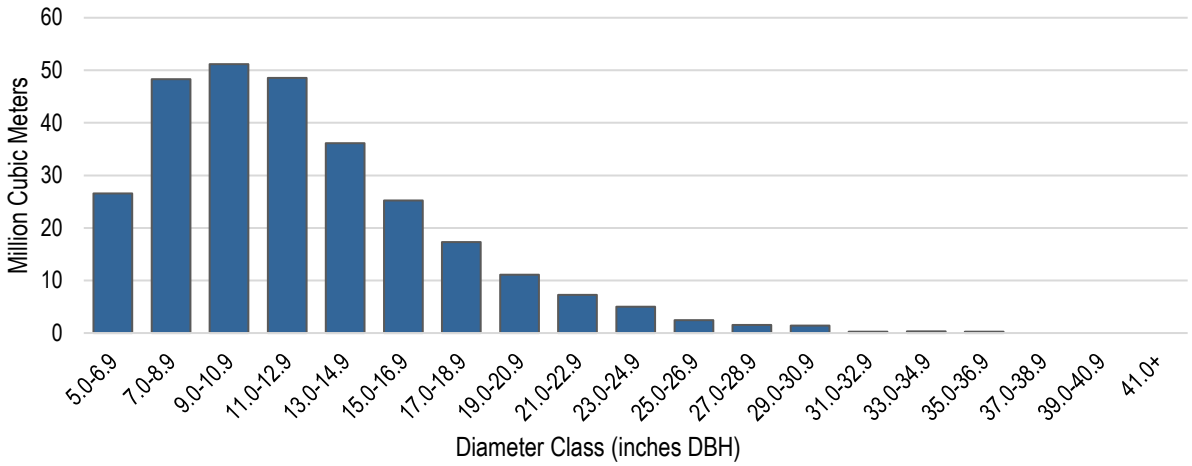
Diameter Class (inches DBH)	*Softwood*		*Hardwood*		*Total*	
	Volume (000 m3)	Distribution	Volume (000 m3)	Distribution	Volume (000 m3)	Distribution
5.0-6.9	26,578	9%	11,433	11%	38,011	10%
7.0-8.9	48,303	17%	13,406	12%	61,709	16%
9.0-10.9	51,172	18%	14,237	13%	65,409	17%
11.0-12.9	48,531	17%	13,627	13%	62,159	16%
13.0-14.9	36,145	13%	12,850	12%	48,995	13%
15.0-16.9	25,240	9%	11,067	10%	36,307	9%
17.0-18.9	17,299	6%	9,131	8%	26,429	7%
19.0-20.9	11,087	4%	6,341	6%	17,427	4%
21.0-22.9	7,234	3%	6,187	6%	13,421	3%
23.0-24.9	5,015	2%	3,215	3%	8,230	2%
25.0-26.9	2,453	1%	1,928	2%	4,380	1%
27.0-28.9	1,562	1%	1,895	2%	3,457	1%
29.0-30.9	1,416	1%	556	1%	1,972	1%
31.0-32.9	258	0%	1,460	1%	1,718	0%
33.0-34.9	326	0%	222	0%	548	0%
35.0-36.9	261	0%	450	0%	711	0%
37.0-38.9	0	0%	447	0%	447	0%
39.0-40.9	0	0%	0	0%	0	0%
41.0+	0	0%	0	0%	0	0%
Total	**282,879**	**100%**	**108,452**	**100%**	**391,331**	**100%**

Source: USDA - US Forest Service

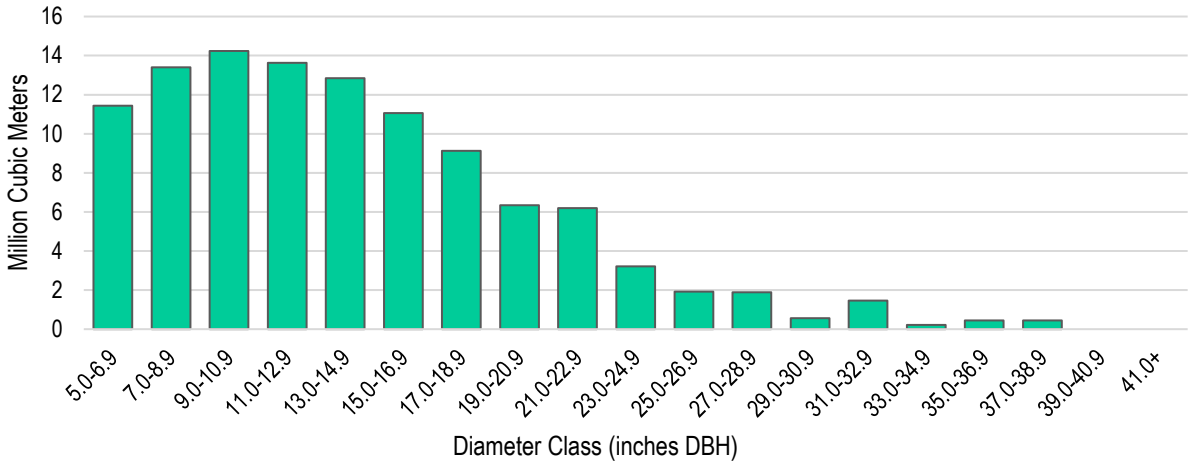
***Figure 8**. Georgia Catchment Area - Distribution of Growing Stock Volume on Timberland by Diameter Class (2018)*



(a) Total Growing Stock Inventory



(b) Softwood Growing Stock Inventory



(c) Hardwood Growing Stock Inventory

In addition, FIA estimates of diameter class distribution by major species group allow us to break down volume estimates according to major timber product. Also note that *softwood* and *pine* are used interchangeably, as pine constitutes 100% of total softwood inventory in the catchment area (according to FIA data). Individual product specifications are defined as follows:

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

Based on these product specifications, approximately 133 million m^3 (34%) of total growing stock inventory is classified as pine sawtimber, compared to 75 million m^3 (19%) of pine chip-n-saw, 75 million m^3 (19%) of pine pulpwood, 63 million m^3 (16%) of hardwood sawtimber, and 46 million m^3 (12%) of hardwood pulpwood.

***Table 9**. Georgia Catchment Area - Distribution of Total Growing Stock Volume by Major Timber Product (2018)*

Product	Volume (000 m^3)	Distribution
Pine Sawtimber	132,724	34%
Pine Chip-n-saw	75,216	19%
Pine Pulpwood	74,939	19%
Hardwood Sawtimber	62,644	16%
Hardwood Pulpwood	45,809	12%
Total	**391,331**	**100%**

Source: USDA - US Forest Service

3.2.3 *Age Class Distribution*

Distribution of total growing stock volume on timberland by age class is bimodal, with 50% of total inventory 11-40 years of age and 29% of total inventory 51-80 years of age (see Figure 9). However, this is explained by major species composition and its respective age class distribution.

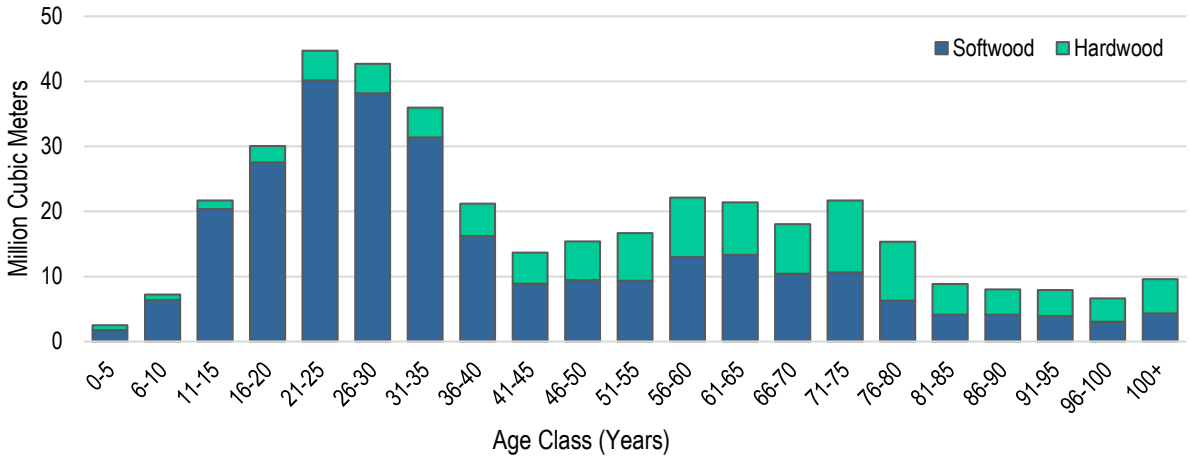
According to USFS estimates, softwood growing stock inventory averages an estimated 39.1 years of age, with 61% (158 million m^3) of total softwood inventory 11-35 years of age and 71% (200 million m^3) 50 years of age or younger. In contrast, hardwood inventory averages an estimated 60.6 years of age, with 54% (58 million m^3) of hardwood inventory 46-80 years of age and 83% (90 million m^3) 21-90 years of age.

***Table 10**. Georgia Catchment Area - Distribution of Growing Stock Volume by Age Class & Major Species (2018)*

	Softwood		*Hardwood*		*Total*	
Age Class (Years)	**Volume** (000 m3)	**Distribution**	**Volume** (000 m3)	**Distribution**	**Volume** (000 m3)	**Distribution**
0-5	1,753	1%	771	1%	2,524	1%
6-10	6,408	2%	819	1%	7,227	2%
11-15	20,375	7%	1,323	1%	21,698	6%
16-20	27,552	10%	2,501	2%	30,054	8%
21-25	40,150	14%	4,581	4%	44,731	11%
26-30	38,179	13%	4,523	4%	42,701	11%
31-35	31,405	11%	4,552	4%	35,957	9%
36-40	16,207	6%	5,009	5%	21,216	5%
41-45	8,895	3%	4,763	4%	13,658	3%
46-50	9,432	3%	5,980	6%	15,412	4%
51-55	9,346	3%	7,315	7%	16,661	4%
56-60	12,968	5%	9,147	8%	22,115	6%
61-65	13,303	5%	8,097	7%	21,400	5%
66-70	10,434	4%	7,594	7%	18,028	5%
71-75	10,605	4%	11,059	10%	21,664	6%
76-80	6,305	2%	9,024	8%	15,329	4%
81-85	4,107	1%	4,717	4%	8,824	2%
86-90	4,130	1%	3,870	4%	8,001	2%
91-95	3,941	1%	3,996	4%	7,937	2%
96-100	3,039	1%	3,570	3%	6,609	2%
100+	4,343	2%	5,241	5%	9,584	2%
Total	**282,879**	**100%**	**108,452**	**100%**	**391,331**	**100%**

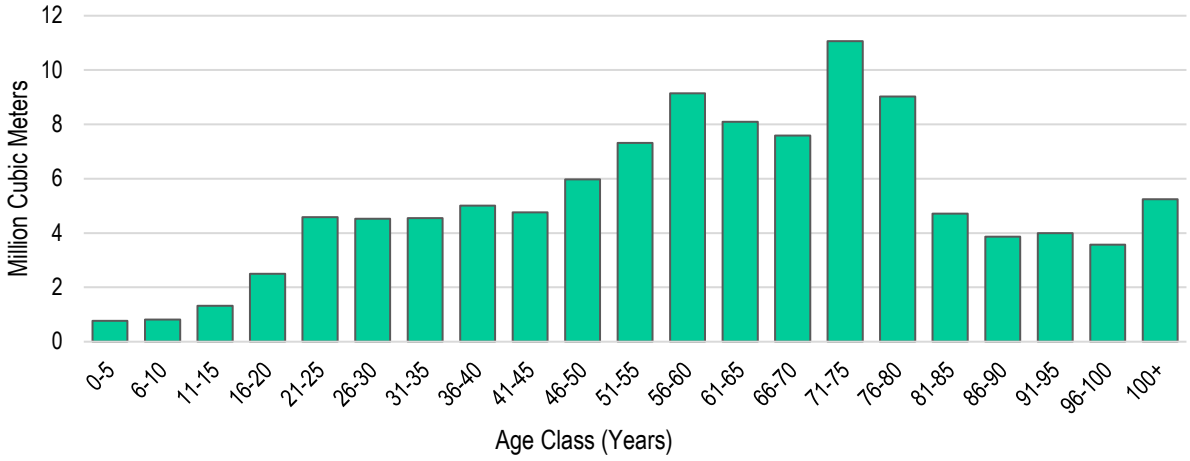
Source: USDA - US Forest Service

***Figure 9**. Georgia Catchment Area - Distribution of Growing Stock Volume on Timberland by Age Class (2018)*



(a) Total Growing Stock Inventory

(b) Softwood Growing Stock Inventory



(c) Hardwood Growing Stock Inventory

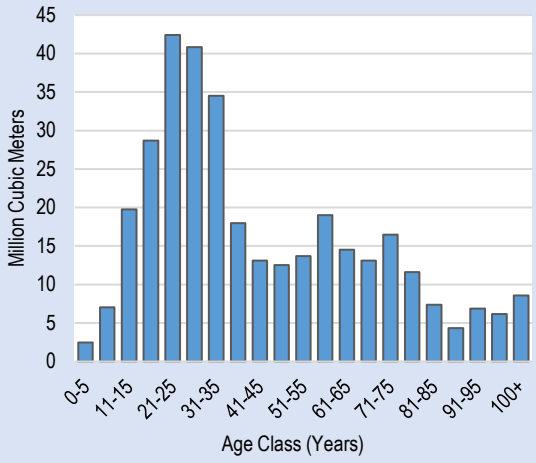
Growing Stock Inventory by Age Class & Ownership Group

Note that the bimodal distribution of total growing stock inventory by age class (see Figure 9 on pg. 30) is also influenced by the differing approaches to timber management (i.e. private versus public land management).

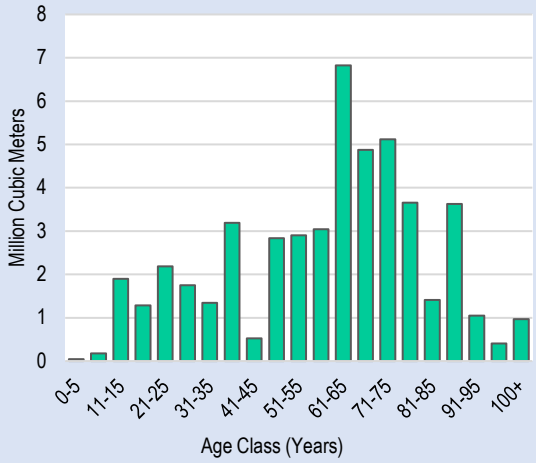
Figure 10 shows total growing stock inventory on timberland in the Georgia catchment area in 2018 by both age class and ownership group. According to USFS data, nearly two-thirds of growing stock inventory on privately-owned timberland is 50 years of age or younger. Specifically, looking at Figure 10(a) below, the high distribution of privately-owned timber inventory between 0 and 40 years of age is largely a reflection of the working forest area in the Georgia catchment area timber. This is predominantly pine forest with shorter rotation lengths (typically less than 35 years).

On the other hand, over two-thirds of growing stock inventory on public timberland is older than 50 years of age. Specifically, 54% of public timber inventory is 51-80 years of age (see Figure 10(b)). In general, the US Forest Service manages public timberland on a maximum sustained yield basis, which for softwood (pine) timber translates to rotation lengths in excess of 50 years. So, looking back at Figure 9, the bimodal distribution of timber inventory (softwood inventory in particular) reflects not only the private working forest area but also publicly owned and managed forests in the Georgia catchment area.

***Figure 10**. Georgia Catchment Area - Distribution of Growing Stock Volume on Timberland by Age Class & Major Ownership Group (2018)*



(a) Private Ownership



(b) Public Ownership

3.2.4 *Stand Origin*

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

Based on the most current US Forest Service FIA estimates, approximately 61% of total growing stock volume in the catchment area, or 240 million m^3, is naturally regenerated timber, compared to 39% (151 million m^3) planted. However, stand origin distribution varies widely by major species group.

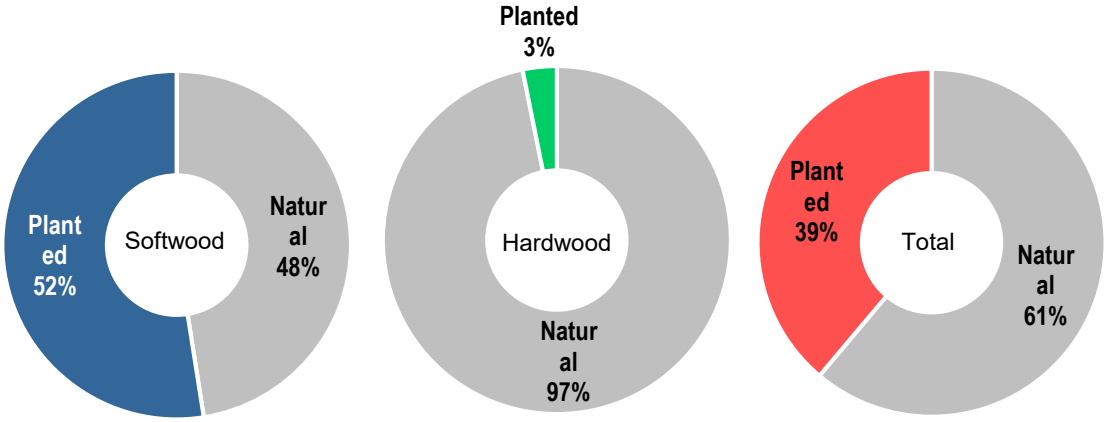
US Forest Service data shows approximately 48% (136 million m^3) of softwood growing stock inventory is naturally regenerated versus 52% (148 million m^3) planted. In contrast, approximately 97% (104 million m^3) of hardwood inventory is naturally regenerated, compared to 3% (3 million m^3) planted.

***Table 11**. Georgia Catchment Area - Growing Stock Volume on Timberland by Stand Origin & Major Species (2018)*

Stand Origin	Softwood		Hardwood		Total	
	Volume (000 m3)	Distribution	Volume (000 m3)	Distribution	Volume (000 m3)	Distribution
Naturally Regenerated	136,055	48%	104,016	97%	240,072	61%
Planted	147,833	52%	3,426	3%	151,259	39%
Total	**283,888**	**100%**	**107,443**	**100%**	**391,331**	**100%**

Source: USDA - US Forest Service

***Figure 11**. Georgia Catchment Area - Distribution of Growing Stock Volume on Timberland by Stand Origin & Major Species (2018)*



3.3 Timber Growth & Removals

3.3.1 *Timber Growth*

According to US Forest Service estimates, net annual growth of growing stock timber in the Georgia catchment area totaled an estimated 23.6 million m^3 in 2018, the latest available. Specifically, 86% (20.2 million m^3) of total growth was attributed to softwood species compared to 14% (3.3 million m^3) hardwood species.

Annual growth was highest for pine pulpwood, totaling 9.2 million m^3 and accounting for 39% of total volume growth, followed by pine chip-n-saw at 5.6 million m^3 (24%), pine sawtimber at 5.4 million m^3 (23%), hardwood pulpwood at 2.2 million m^3 (9%), and hardwood sawtimber at 1.2 million m^3 (5%).

***Table 12**. Georgia Catchment Area - Net Growth of Growing Stock Timber by Major Timber Product (2018)*

Product	Volume Growth (000 m^3)	% of Total Growth
Pine Sawtimber	5,438	23%
Pine Chip-n-saw	5,598	24%
Pine Pulpwood	9,193	39%
Hardwood Sawtimber	1,182	5%
Hardwood Pulpwood	2,152	9%
Total	**23,563**	**100%**

Source: USDA - US Forest Service

3.3.2 *Timber Removals*

According to the USFS, timber removals in the catchment area totaled 21.1 million m^3 in 2018, of which approximately 93% (19.7 million m^3) was softwood timber and 7% (1.4 million m^3) was hardwood timber.

Of the five major timber products, removals were highest for pine pulpwood, totaling 8.7 million m^3 and accounting for 41% of total removals, followed by pine chip-n-saw at 5.7 million m^3 (27%), pine sawtimber at 5.3 million m^3 (25%), hardwood pulpwood at 0.8 million m^3 (4%), and hardwood sawtimber at 0.6 million m^3 (3%).

***Table 13**. Georgia Catchment Area - Timber Removals by Major Timber Product (2018)*

Product	Removals (000 m^3)	% of Total Removals
Pine Sawtimber	5,336	25%
Pine Chip-n-saw	5,692	27%
Pine Pulpwood	8,654	41%
Hardwood Sawtimber	622	3%
Hardwood Pulpwood	827	4%
Total	**21,131**	**100%**

Source: USDA - US Forest Service

3.3.3 *Growth-to-Removals Ratios*

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

According to US Forest Service data from 2018, the latest available, overall inventory growth totaled 23.6 million m^3, compared to total removals of 21.1 million m^3, or a growth-to-removals ratio of 1.12. The growth-to-removal ratio for softwood species was 1.03, compared to 2.30 for hardwood species.

Growth-to-removals ratios by species and individual timber product in 2018 were as follows: pine sawtimber=1.02, pine chip-n-saw=0.98, pine pulpwood=1.06, hardwood sawtimber=1.90, and hardwood pulpwood=2.60. Note that growth-to-removals ratios for the three major pine products were right around 1.0, indicating balanced market conditions. In contrast, growth-to-removals ratios for the major hardwood products were well above 1.0, indicating sustainable market conditions as well as oversupply.

***Table 14**. Georgia Catchment Area - Annual Growth, Removals, & Growth-to-Removal Ratios by Major Timber Product (2018)*

Softwood (Pine)	Growth (000 m^3)	Removals (000 m^3)	G:R Ratio
Pine Sawtimber	5,438	5,336	1.02
Pine Chip-n-saw	5,598	5,692	0.98
Pine Pulpwood	9,193	8,654	1.06
Softwood (Pine) Total	**20,229**	**19,682**	**1.03**

Hardwood	Growth (000 m^3)	Removals (000 m^3)	G:R Ratio
Hardwood Sawtimber	1,182	622	1.90
Hardwood Pulpwood	2,152	827	2.60
Hardwood Total	**3,335**	**1,449**	**2.30**

Product	Growth (000 m^3)	Removals (000 m^3)	G:R Ratio
Sawtimber	12,218	11,651	1.05
Pulpwood	11,345	9,481	1.20
Total	**23,563**	**21,131**	**1.12**

Source: USDA - US Forest Service

4. Wood Demand & Raw Material Cost Assessment

4.1 Mill Capacity & Wood Demand

According to TimberMart-South's mill database, as of mid-2020, there were 134 wood-consuming mills operating in and around the Georgia catchment area (within roughly 280 kilometers of Georgia Biomass). This includes 76 lumber mills (59 softwood mills and 17 hardwood mills), 18 pulp/paper mills, 9 panel (plywood/OSB) mills, 16 chip mills, and 11 pellet mills.

Total production capacity associated with these 134 mills translates to nearly 58 million metric tons of roundwood per year. However, not all wood consumed by these mills are procured from within the Georgia catchment area. Based on the relative location of these mills to this catchment area, the total allocated capacity of these mills to the Georgia catchment area is estimated at approximately 24.6 million metric tons of roundwood.

***Table 15**. Number of Mills, Total Mill Capacity, & Catchment Area Allocated Mill Capacity (2019)*

Mill Type	No. Mills	Total Capacity (Metric Tons*)	Catchment Area Allocation (Metric Tons*)
Lumber	76	23,006,216	7,403,878
Pulp / Paper	18	23,289,066	12,291,767
Plywood / OSB	9	3,935,339	1,028,258
Chip	16	4,168,557	2,020,423
Pellet	11	3,304,864	1,870,044
Total	**134**	**57,704,043**	**24,614,370**

*Roundwood equivalent volume

Source: TimberMart-South; Hood Consulting

***Table 16**. Georgia Catchment Area - Mill List (2020)*

Mill Name / Company	City	County	State	Capacity	Units	Demand*
		Softwood Sawmill				
Dupont Yard	Homerville	Clinch	GA	10	MM Bf	71,416
Warren & Griffin	Williams	Colleton	SC	10	MM Bf	71,416
Tatum Bros Lumber	Lawtey	Bradford	FL	15	MM Bf	107,123
Cameron Lumber	Cameron	Calhoun	SC	15	MM Bf	107,123
Shearouse Lumber	Pooler	Chatham	GA	20	MM Bf	108,530
RB Lumber	Riceboro	Liberty	GA	21	MM Bf	149,973
Hubert Moore Lumber	Alapaha	Berrien	GA	25	MM Bf	178,539
Great South Timber and Lumber	Lake City	Columbia	FL	29	MM Bf	207,105
Georgia-Pacific	McCormick	McCormick	SC	50	MM Bf	209,165
W.M. Sheppard Lumber	Brooklet	Bulloch	GA	62	MM Bf	259,365
Griffin Lumber	Cordele	Crisp	GA	63	MM Bf	263,548
Pollard Lumber	Appling	Columbia	GA	65	MM Bf	271,915
Canfor	Thomasville	Thomas	GA	65	MM Bf	271,915
Varn Wood Products	Hoboken	Brantley	GA	66	MM Bf	276,098
Claude Howard Lumber	Statesboro	Bulloch	GA	76	MM Bf	317,931
Burt Lumber	Washington	Wilkes	GA	80	MM Bf	334,664
Hood Industries	Metcalf	Thomas	GA	90	MM Bf	376,497
Interfor	Eatonton	Putnam	GA	90	MM Bf	376,497
West Fraser	Maxville	Clay	FL	95	MM Bf	397,414
Georgia-Pacific	Cross City	Dixie	FL	98	MM Bf	409,964
Kapstone Kraft	Summerville	Dorchester	SC	100	MM Bf	391,107
West Fraser	Lake Butler	Union	FL	100	MM Bf	418,330
West Fraser	Whitehouse	Duval	FL	100	MM Bf	418,330
West Fraser	Fitzgerald	Ben Hill	GA	105	MM Bf	439,247
West Fraser	Blackshear	Pierce	GA	108	MM Bf	422,396
West Fraser	Dudley	Laurens	GA	108	MM Bf	422,396
West Fraser	Perry	Taylor	FL	113	MM Bf	441,951
Rex Lumber	Graceville	Jackson	FL	120	MM Bf	469,328
Rex Lumber	Bristol	Liberty	FL	120	MM Bf	501,996
Interfor	Swainsboro	Emanuel	GA	125	MM Bf	488,884
Spanish Trail Lumber	Cypress	Jackson	FL	135	MM Bf	527,995
Interfor	Meldrim	Effingham	GA	135	MM Bf	527,995
West Fraser	Augusta	Richmond	GA	137	MM Bf	535,817
Langdale Forest Products	Valdosta	Lowndes	GA	145	MM Bf	567,105
Interfor	Perry	Houston	GA	150	MM Bf	586,661
Canfor	Moultrie	Colquitt	GA	150	MM Bf	627,495
Conifex Timber Inc.	Cross City	Dixie	FL	155	MM Bf	606,216
Interfor	Baxley	Appling	GA	160	MM Bf	625,771
Collums Lumber Products	Allendale	Allendale	SC	165	MM Bf	645,327
Interfor	Thomaston	Upson	GA	170	MM Bf	664,882
Dempsey Wood Products	Rowesville	Orangeburg	SC	200	MM Bf	1,156,080
Canfor	Estill	Hampton	SC	210	MM Bf	821,325
Interfor	Preston	Webster	GA	225	MM Bf	879,991
Georgia-Pacific	Albany	Dougherty	GA	300	MM bf	1,173,321
Georgia-Pacific	Warrenton	Warren	GA	350	MM Bf	1,368,875
		Hardwood Sawmill				
Denmark Lumber	Denmark	Bamberg	SC	10	MM Bf	65,064
Woody Lumber	Irwinton	Wilkinson	GA	12	MM Bf	78,076
Oak Crest Lumber	Buena Vista	Marion	GA	14	MM Bf	91,089
T & S Hardwoods	Milledgeville	Baldwin	GA	20	MM Bf	130,127
Southern Forest Industries	Smarr	Monroe	GA	38	MM Bf	233,793
Thompson Hardwoods	Hazlehurst	Jeff Davis	GA	43	MM Bf	279,773
Beasley Forest Products	Hazlehurst	Jeff Davis	GA	90	MM Bf	585,572
Battle Lumber	Wadley	Jefferson	GA	93	MM Bf	605,091

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

Mill Name / Company	City	County	State	Capacity	Units	Demand*
		Plywood/Panel Mill				
Cross City Veneer Co.	Cross City	Dixie	FL	25	MM SqFt	44,238
Truax Veneer Co.	Lyons	Toombs	GA	25	MM SqFt	44,238
Southern Veneer Products	Fitzgerald	Ben Hill	GA	66	MM SqFt	116,124
Sierra Pine	Adel	Cook	GA	138	MM SqFt	-
Georgia-Pacific	Thomson	McDuffie	GA	145	MM SqFt	240,789
Coastal Lumber Co.	Havana	Gadsden	FL	215	MM SqFt	380,445
Langboard Inc	Willacoochee	Atkinson	GA	240	MM SqFt	-
Langboard Inc	Quitman	Brooks	GA	275	MM SqFt	456,670
Georgia-Pacific	Fairfax	Allendale	SC	400	MM SqFt	664,247
Georgia-Pacific	Hosford	Liberty	FL	598	MM SqFt	992,219
Norboard	Cordele	Crisp	GA	600	MM SqFt	996,370
		Pulp/Paper Mill				
Rayonier Advanced Materials	Fernandina Beach	Nassau	FL	155	M tons	504,946
Intersate Resources	Riceboro	Liberty	GA	350	M tons	1,140,200
International Paper	Oglethorpe	Macon	GA	350	M tons	1,140,200
International Paper	Port Wentworth	Chatham	GA	385	M tons	1,254,220
Georgia-Pacific	Perry	Taylor	FL	510	M tons	1,661,434
Georgia-Pacific	Palatka	Putnam	FL	520	M tons	1,694,011
Graphic Packaging	Macon	Bibb	GA	548	M tons	1,785,227
Rayonier Advanced Materials	Jesup	Wayne	GA	575	M tons	1,873,185
WestRock	Dublin	Laurens	GA	585	M tons	1,905,762
WestRock	Jacksonville	Duval	FL	588	M tons	-
Packaging Corporation of America	Valdosta	Lowndes	GA	604	M tons	1,967,659
International Paper	Augusta	Richmond	GA	650	M tons	2,117,514
WestRock	Charleston	Charleston	SC	687	M tons	654,583
WestRock	Fernandina Beach	Nassau	FL	930	M tons	3,029,673
Georgia-Pacific	Brunswick	Glynn	GA	942	M tons	3,068,766
International Paper	Savannah	Chatham	GA	980	M tons	3,192,559
Georgia-Pacific	Cedar Springs	Early	GA	1185	M tons	3,860,390
		Chip Mill				
Rayonier Advanced Materials	Fernandina Beach	Nassau	FL	-	M tons	-
Macon Chips Inc.	Macon	Bibb	GA	-	M tons	-
Intersate Resources	Riceboro	Liberty	GA	-	M tons	-
Price Industries	Valdosta	Lowndes	GA	-	M tons	-
Georgia-Pacific	Palatka	Putnam	FL	-	M tons	-
Southern Wood Suppliers	Oglethorpe	Macon	GA	200	M tons	190,563
Price Industries	Gordon	Wilkinson	GA	200	M tons	190,563
Price Industries	Cairo	Grady	GA	300	M tons	285,844
Price Industries	Sandersville	Washington	GA	300	M tons	285,844
Rayonier Advanced Materials	Eastman	Dodge	GA	350	M tons	333,485
Kapstone Kraft	Hampton	Hampton	SC	350	M tons	333,485
Price Industries	Maxville	Duval	FL	390	M tons	371,597
Price Industries	St. George	Charlton	GA	390	M tons	371,597
Price Industries	Collins	Tattnall	GA	480	M tons	457,350
Rayonier Advanced Materials	Patterson	Pierce	GA	690	M tons	657,441
Kapstone Kraft	Summerville	Dorchester	SC	725	M tons	690,789
		Pellet Mill				
Rockwood Pellets	The Rock	Upson	GA	15	M tons	-
Briar Creek Wood Fibers	Sylvania	Screven	GA	75	M tons	-
Varn Wood Products	Hoboken	Brantley	GA	80	M tons	-
Fram Renewable Fuels	Lumber City	Telfair	GA	120	M tons	-
Fram Renewable Fuels	Baxley	Appling	GA	130	M tons	-
Fram Renewable Fuels	Nahunta	Brantley	GA	150	M tons	272,232
LJR Forest Products	Swainsboro	Emanuel	GA	160	M tons	-
Ridgeland Pellets	Ridgeland	Jasper	SC	200	M tons	-
Fram Renewable Fuels	Hazlehurst	Jeff Davis	GA	550	M tons	998,185
Enviva Biomass	Cottondale	Jackson	FL	730	M tons	1,324,864
Georgia Biomass	Waycross	Ware	GA	750	M tons	1,361,162

*Roundwood demand (metric tons)

***Figure 12**. Georgia Catchment Area - Mill Map (2020)*

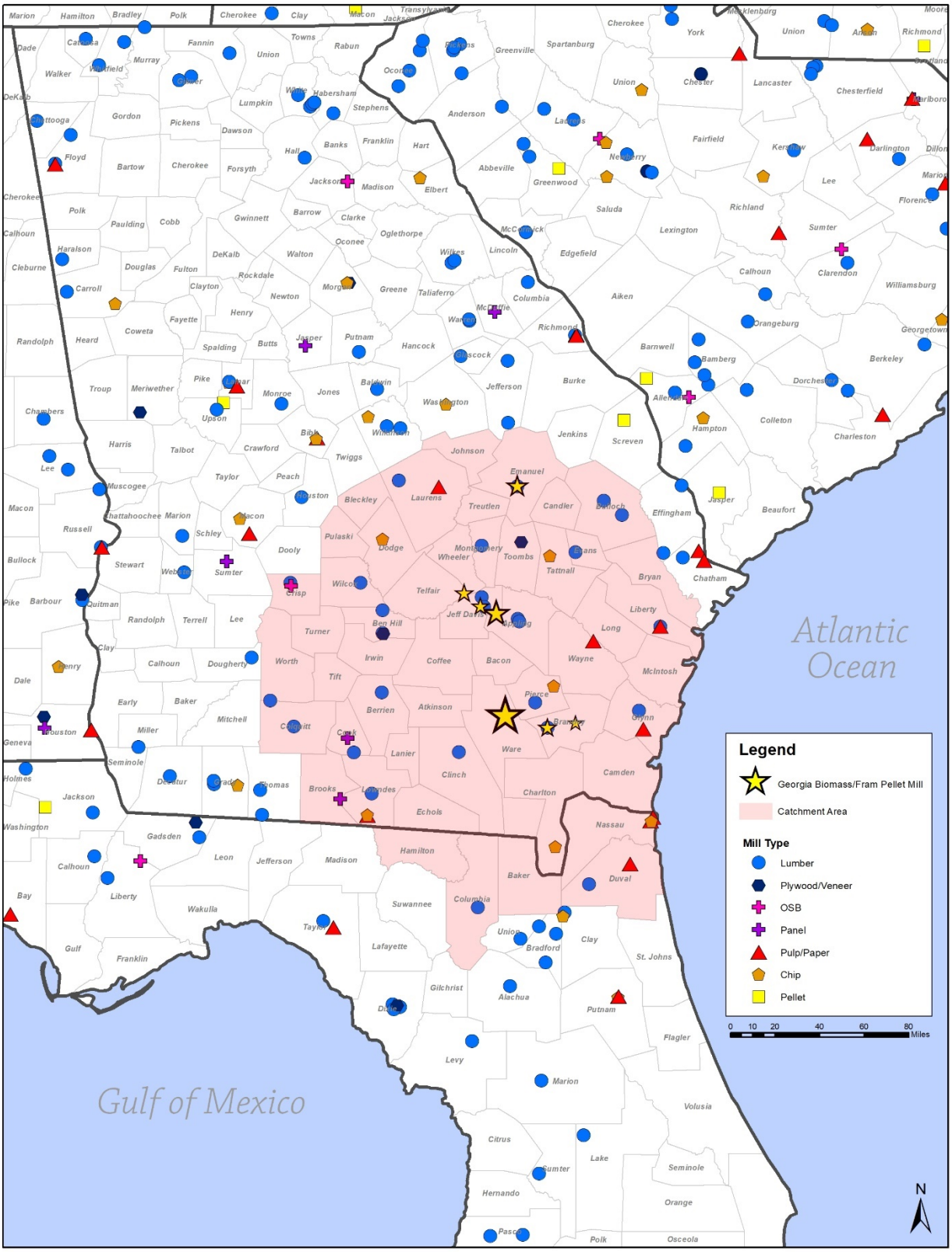


***Figure 13**. Georgia Catchment Area - Lumber Mills (2020)*

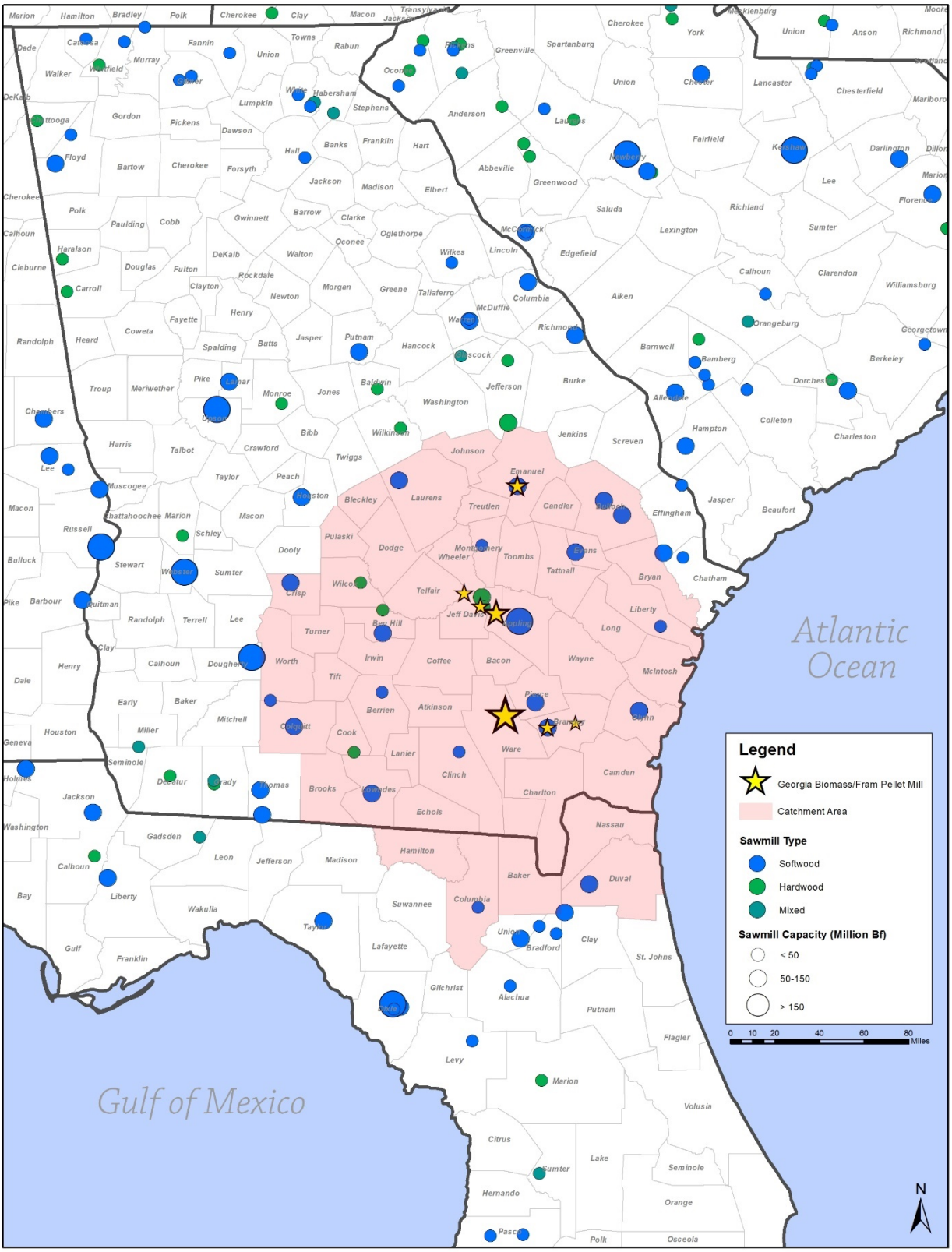


***Figure 14**. Georgia Catchment Area - Panel Mills (2020)*

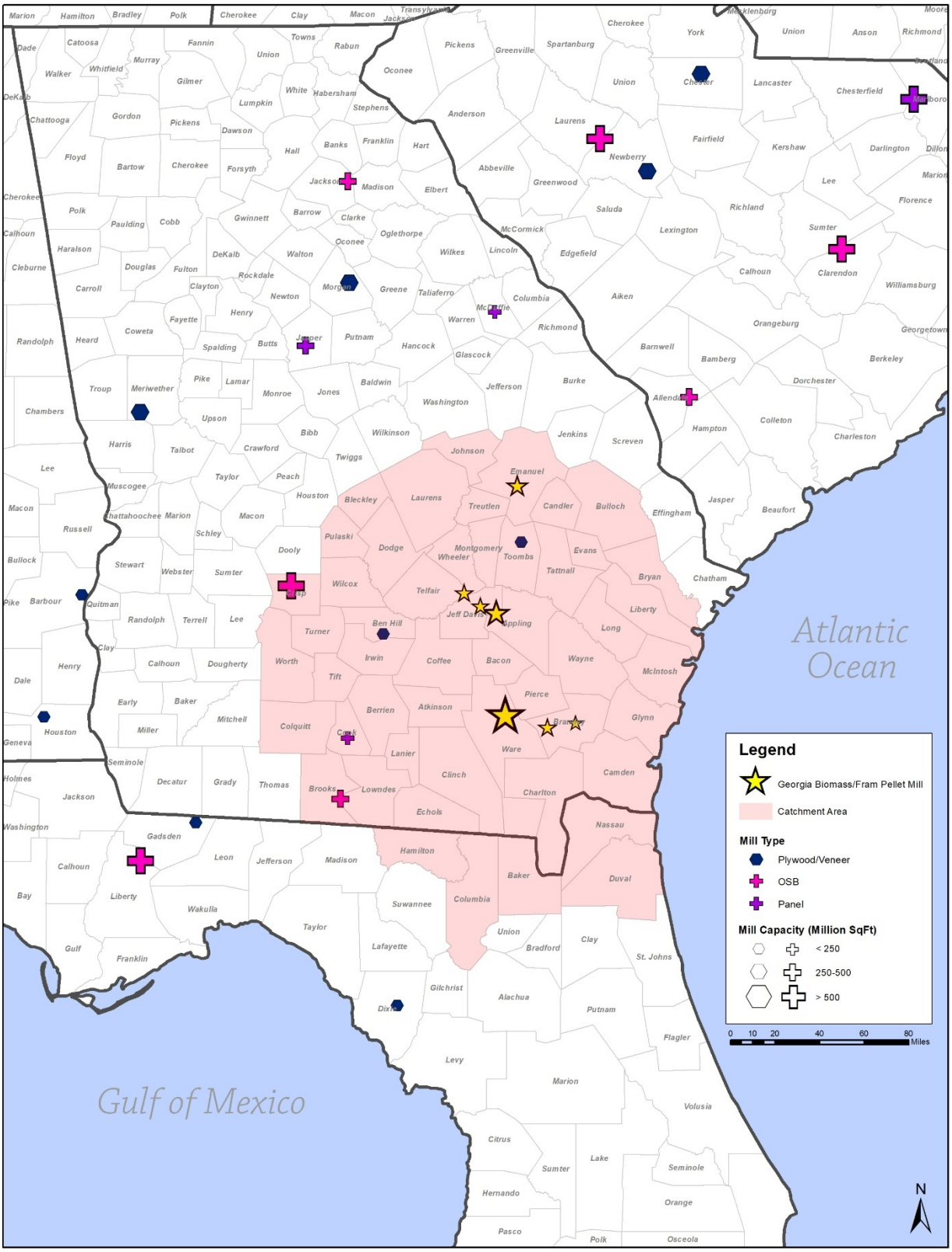
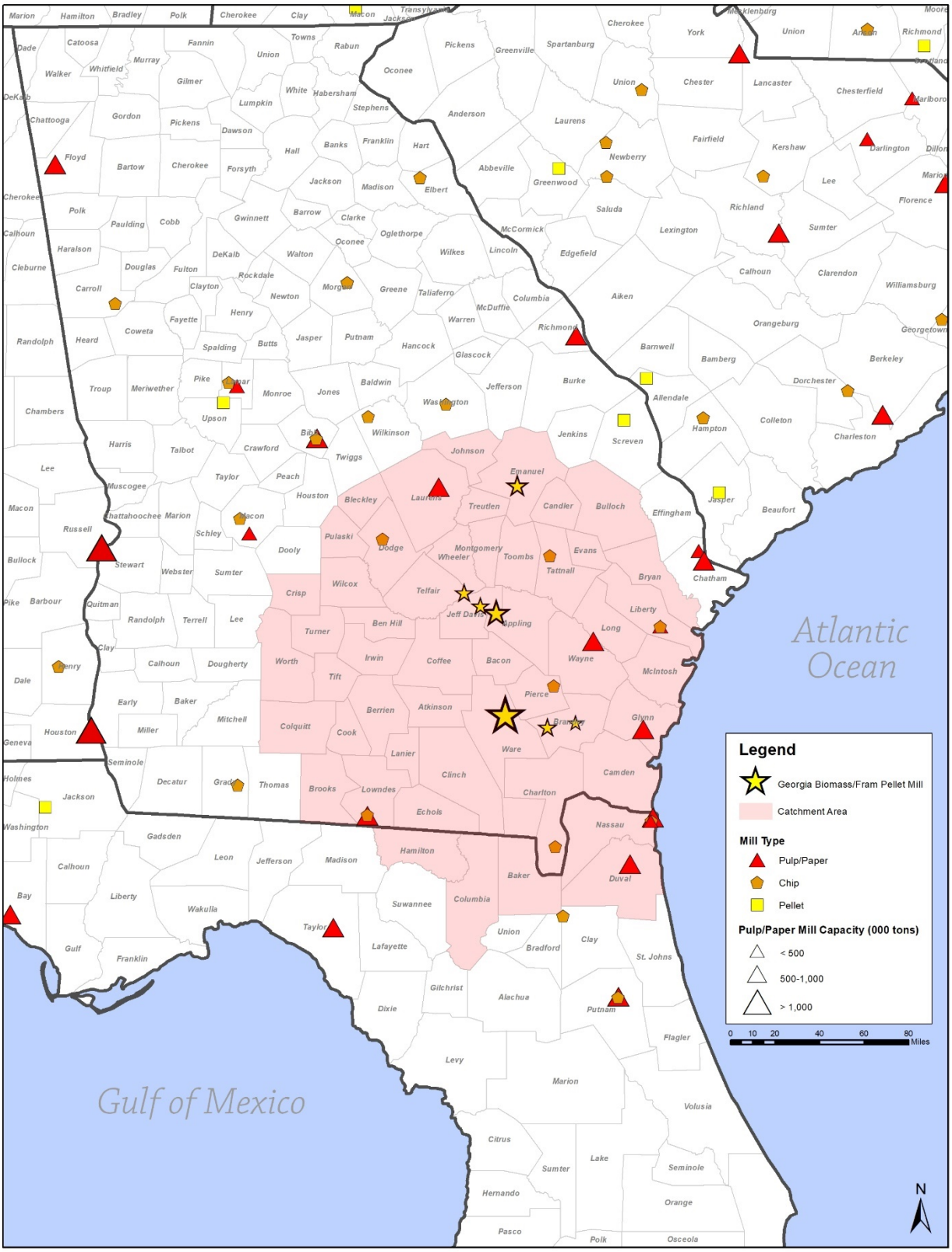


***Figure 15**. Georgia Catchment Area - Pulp/Paper, Pellet, & Chip Mills (2020)*



4.1.1 *Catchment Area Wood Demand*

Note that total capacity is not the same as actual demand, but rather the maximum potential demand associated with mills running at full production capacity. While total capacity is estimated at approximately 24.6 million metric tons annually, actual wood demand[5] in the Georgia catchment area in 2018, the latest available, was estimated at 23.6 million metric tons.

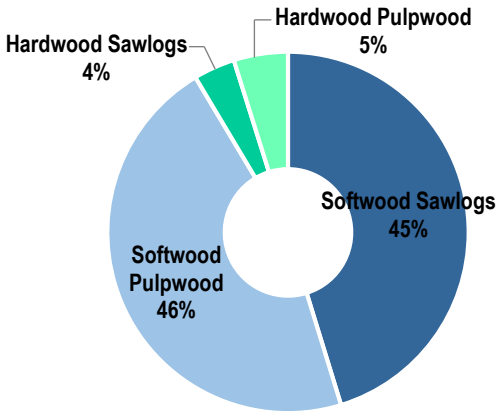
Distribution of total wood demand by major species in 2018 included 91% (21.5 million metric tons) softwood versus 9% (2.0 million metric tons) hardwood. Specifically, 51% of total softwood demand was attributed to softwood pulpwood compared to 49% softwood sawlogs. Similarly, of total hardwood demand, 57% was attributed to hardwood pulpwood versus 43% hardwood sawlogs.

***Table 17**. Georgia Catchment Area - Wood Demand (2018)*

Major Species / Product	Demand (Metric Tons)	% of Total
Softwood:		
Sawlogs	10,659,387	45%
Pulpwood	10,878,622	46%
Softwood Total	*21,538,009*	*91%*
Hardwood:		
Sawlogs	874,804	4%
Pulpwood	1,142,856	5%
Hardwood Total	*2,017,660*	*9%*
Total	**23,555,669**	**100%**

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

***Figure 16**. Georgia Catchment Area - Distribution of Wood Demand by Major Species & Product (2018)*



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

4.1.1.1 *Biomass Demand*

Biomass demand, defined in this analysis as softwood and hardwood pulpwood (roundwood) consumed by pellet or other bioenergy facilities, totaled an estimated 1.2 million metric tons in 2018, the latest available, accounting for approximately 10% of total pulpwood demand. Non-bioenergy related pulpwood demand, almost entirely for pulp/paper production, accounted for approximately 90% of total pulpwood demand in the catchment area.

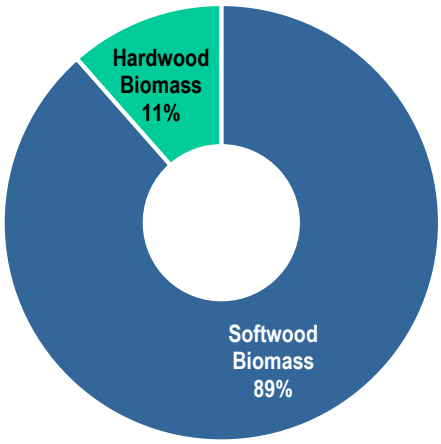
Note that not all wood consumed by a pellet mill or other bioenergy facility is encompassed in biomass demand. Wood consumption (demand) at pellet and other bioenergy facilities generally includes a combination of wood chips and sawmill residuals. However, sawmill residuals are a by-product of the sawmilling process – from the processing of sawlogs, not pulpwood. As such, sawmill residuals consumed by biomass facilities are not included in this calculation of biomass demand.

***Table 18**. Georgia Catchment Area - Biomass Demand & Total Pulpwood Demand (2018)*

Product	Demand (Metric Tons)	% of Total
Softwood Pulpwood:		
Biomass	1,100,947	9%
Other Pulpwood	9,777,675	81%
Softwood Pulpwood Total	*10,878,622*	*90%*
Hardwood Pulpwood:		
Biomass	142,961	1%
Other Pulpwood	999,895	8%
Hardwood Pulpwood Total	*1,142,856*	*10%*
Total Pulpwood	**12,021,479**	**100%**

Source: USDA US Forest Service–TPO; TimberMart-South; Georgia Biomass; Fram Renewable Fuels

***Figure 17**. Georgia Catchment Area - Distribution of Biomass Demand by Major Species (2018)*



4.2 Raw Material Costs

Current and historic prices for both stumpage and delivered timber as well as pulp quality chips have been provided by TimberMart-South (TMS). Note that these prices are specific to the Georgia catchment area and are average market prices calculated from actual timber sales reported to TMS.

4.2.1 *Stumpage (Standing Timber) Prices*

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

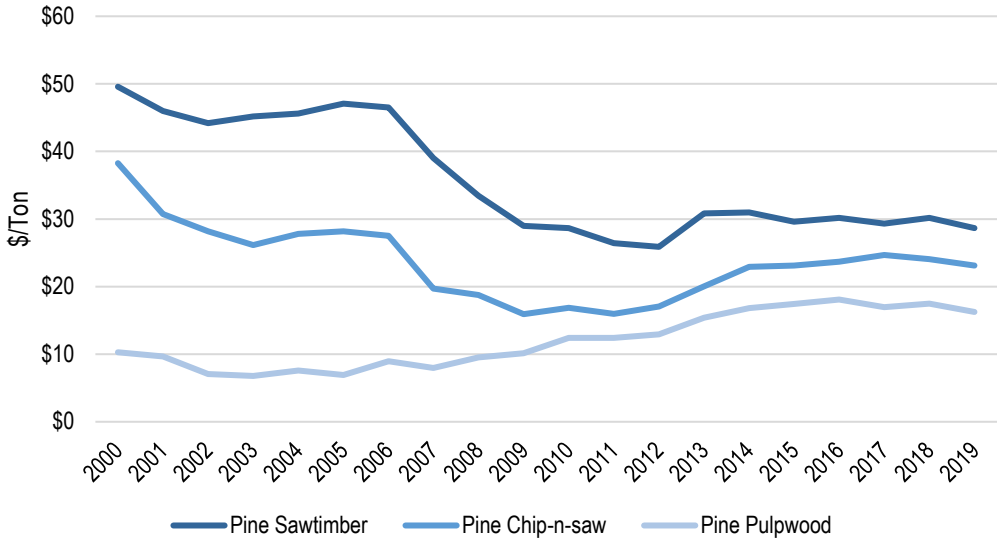
Table 19 below provides annual average stumpage prices in the Georgia catchment area for each of the five major timber products since 2000. Prices are also shown graphically in Figure 18 on the following page. For a detailed assessment of these prices and historic trends, see the *Market Trends, Analysis, & Outlook* section beginning on page 56.

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

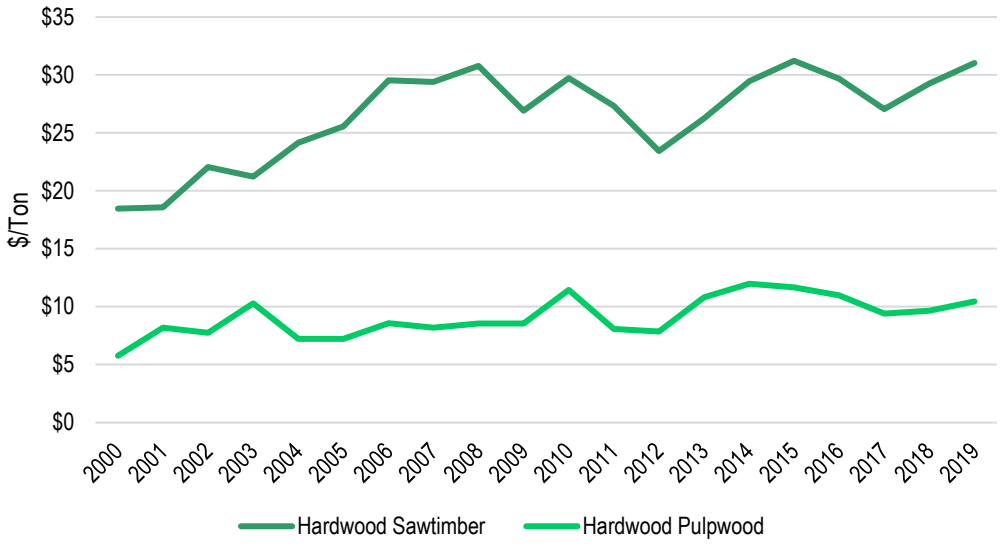
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
			($/Ton)		
2000	$49.57	$38.26	$10.30	$18.47	$5.77
2001	$45.96	$30.74	$9.65	$18.57	$8.20
2002	$44.17	$28.19	$7.05	$22.07	$7.76
2003	$45.19	$26.17	$6.78	$21.22	$10.29
2004	$45.60	$27.82	$7.60	$24.15	$7.23
2005	$47.09	$28.17	$6.93	$25.56	$7.21
2006	$46.51	$27.52	$8.95	$29.54	$8.58
2007	$39.00	$19.69	$7.98	$29.41	$8.19
2008	$33.45	$18.75	$9.53	$30.79	$8.55
2009	$28.97	$15.92	$10.14	$26.91	$8.55
2010	$28.65	$16.85	$12.41	$29.72	$11.44
2011	$26.41	$15.98	$12.39	$27.32	$8.08
2012	$25.88	$17.05	$12.93	$23.44	$7.87
2013	$30.85	$20.03	$15.38	$26.24	$10.80
2014	$30.96	$22.93	$16.80	$29.46	$11.98
2015	$29.59	$23.11	$17.43	$31.22	$11.67
2016	$30.16	$23.66	$18.09	$29.69	$10.98
2017	$29.32	$24.66	$16.97	$27.07	$9.39
2018	$30.18	$24.08	$17.48	$29.25	$9.67
2019	$28.65	$23.12	$16.25	$31.02	$10.47

Source: TimberMart-South

***Figure 18**. Georgia Catchment Area – Annual Stumpage Prices (2000-2019)*



(a) Pine Stumpage Prices



(b) Hardwood Stumpage Prices

4.2.2 *Delivered Timber Prices*

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

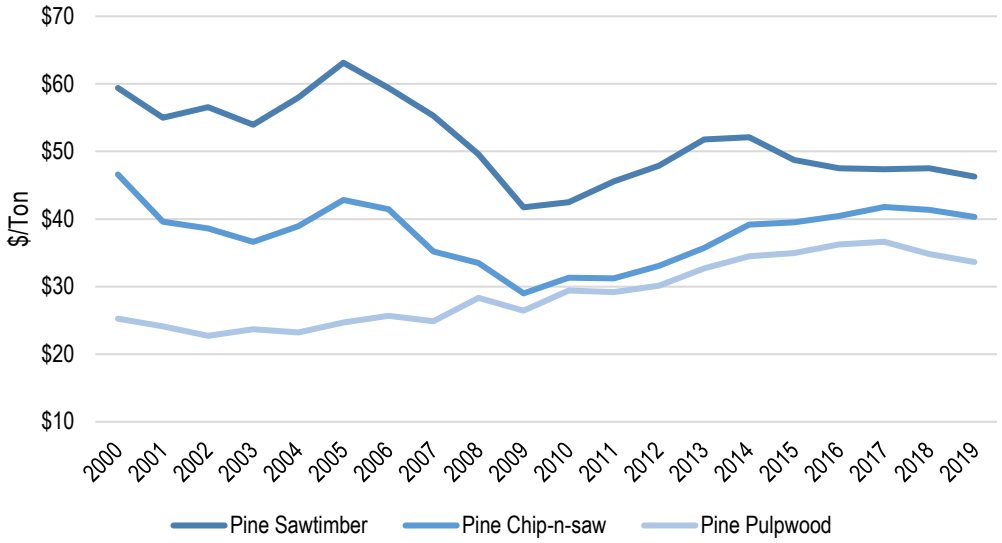
Table 20 below provides annual average delivered timber prices in the Georgia catchment area for each of the five major timber products since 2000. Prices are also shown graphically in Figure 19 on the following page. For a detailed assessment of these prices and historic trends, see the *Market Trends, Analysis, & Outlook* section beginning on page 56.

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

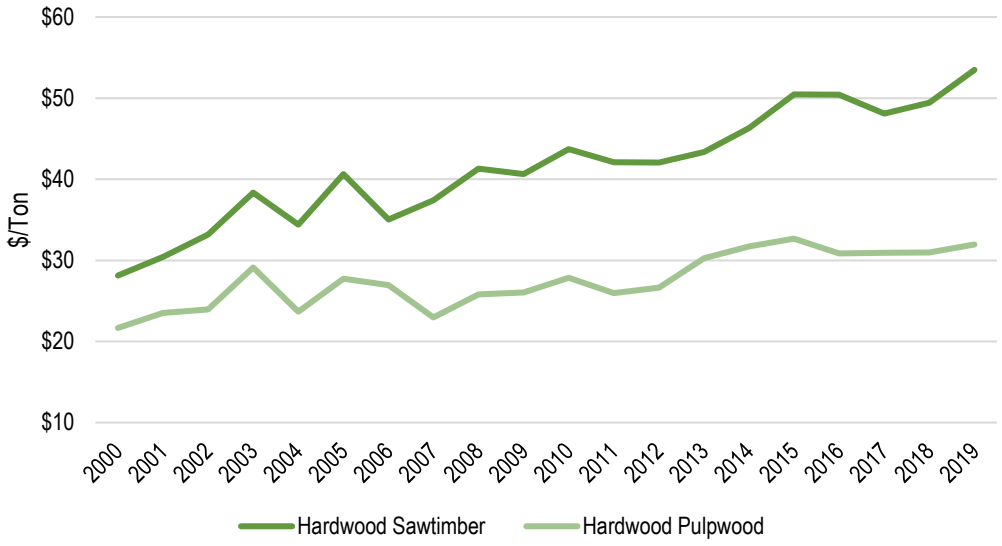
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
			($/Ton)		
2000	$59.40	$46.59	$25.24	$28.13	$21.66
2001	$55.00	$39.59	$24.12	$30.44	$23.51
2002	$56.54	$38.60	$22.72	$33.17	$23.93
2003	$53.94	$36.63	$23.71	$38.33	$29.11
2004	$57.98	$38.92	$23.24	$34.39	$23.66
2005	$63.13	$42.84	$24.70	$40.65	$27.73
2006	$59.41	$41.46	$25.70	$35.05	$26.97
2007	$55.26	$35.21	$24.87	$37.41	$22.95
2008	$49.57	$33.49	$28.35	$41.29	$25.80
2009	$41.73	$29.00	$26.45	$40.65	$26.05
2010	$42.48	$31.29	$29.44	$43.72	$27.84
2011	$45.59	$31.21	$29.16	$42.10	$25.97
2012	$47.87	$33.08	$30.13	$42.07	$26.61
2013	$51.76	$35.74	$32.67	$43.37	$30.24
2014	$52.11	$39.17	$34.48	$46.33	$31.74
2015	$48.74	$39.51	$34.94	$50.48	$32.67
2016	$47.49	$40.46	$36.26	$50.43	$30.84
2017	$47.37	$41.78	$36.63	$48.12	$30.92
2018	$47.49	$41.35	$34.80	$49.45	$30.98
2019	$46.28	$40.29	$33.63	$53.49	$31.96

Source: TimberMart-South

***Figure 19**. Georgia Catchment Area – Annual Delivered Timber Prices (2000-2019)*



(a) Delivered Pine Prices



(b) Delivered Hardwood Prices

4.2.3 *Pulp Quality Chip Prices*

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

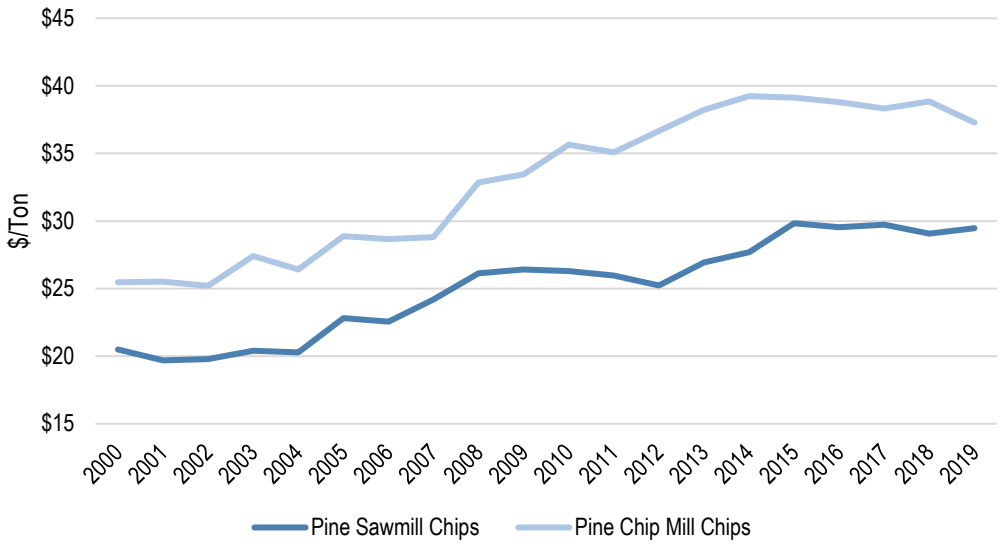
Table 21 below provides annual average pulp quality chip prices in the Georgia catchment area since 2000. Prices are also shown graphically in Figure 20 on the following page. For a detailed assessment of these prices and historic trends, see the *Market Trends, Analysis, & Outlook* section beginning on page 56.

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

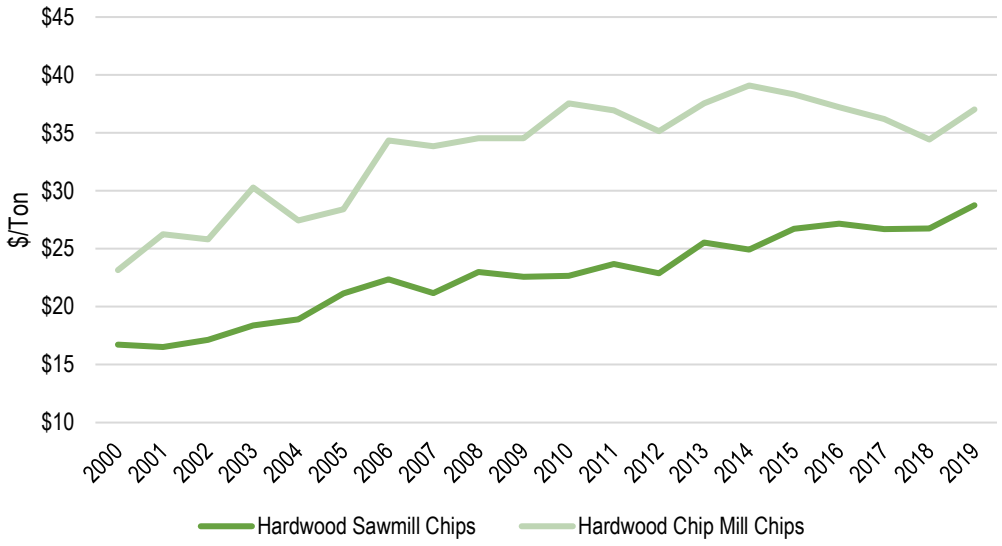
Year	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips
		($/Ton – FOB point of production)		
2000	$20.50	$16.72	$25.48	$23.16
2001	$19.69	$16.52	$25.53	$26.26
2002	$19.79	$17.14	$25.21	$25.82
2003	$20.40	$18.38	$27.41	$30.27
2004	$20.28	$18.92	$26.42	$27.44
2005	$22.82	$21.15	$28.87	$28.41
2006	$22.55	$22.35	$28.68	$34.35
2007	$24.18	$21.17	$28.81	$33.85
2008	$26.12	$22.99	$32.86	$34.55
2009	$26.41	$22.58	$33.46	$34.54
2010	$26.30	$22.65	$35.64	$37.54
2011	$25.97	$23.69	$35.09	$36.94
2012	$25.23	$22.88	$36.67	$35.15
2013	$26.94	$25.54	$38.22	$37.55
2014	$27.69	$24.94	$39.24	$39.09
2015	$29.84	$26.73	$39.12	$38.32
2016	$29.55	$27.17	$38.79	$37.23
2017	$29.74	$26.70	$38.32	$36.20
2018	$29.06	$26.75	$38.85	$34.44
2019	$29.47	$28.76	$37.28	$37.04

Source: TimberMart-South

***Figure 20**. Georgia Catchment Area – Annual Pulp Quality Chip Prices (2000-2019)*



(a) Pine Chip Prices

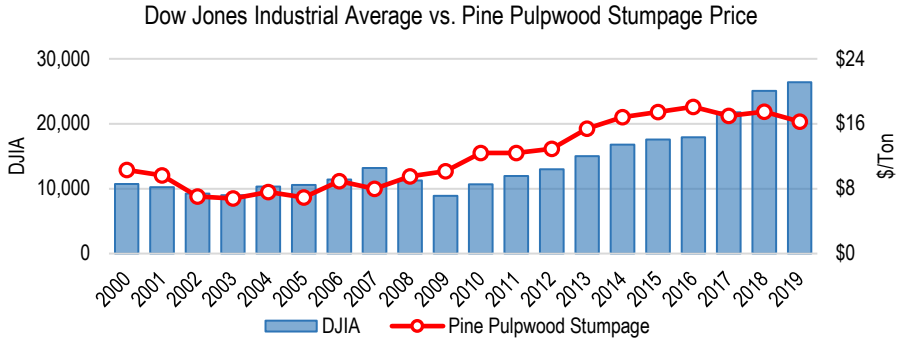


(b) Hardwood Chip Prices

4.2.4 *Timber Price Drivers*

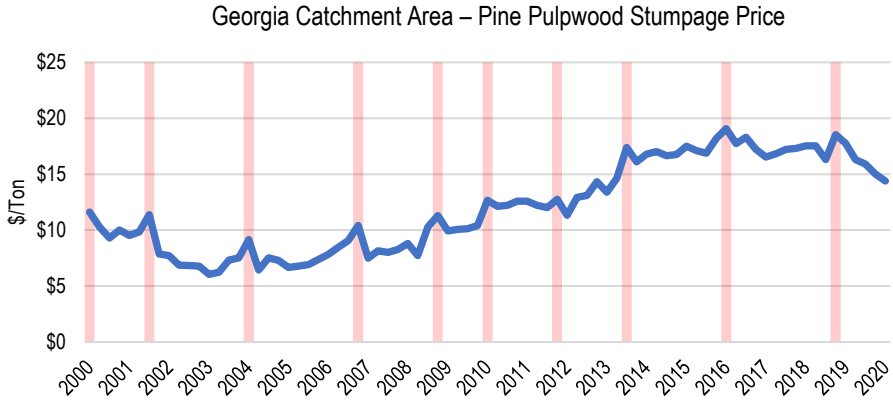
A detailed assessment of raw material prices and price trends is provided in the *Market Trends, Analysis, & Outlook* section beginning on page 56. However, we would like to point out and highlight some of the major price drivers of pine pulpwood – the predominant roundwood product consumed by the bioenergy sector in the Georgia catchment area.

- Domestic Economy. The state of the domestic economy, historically, has been a strong indicator of timber prices in both the Georgia catchment area and across the South. Financial markets generally reflect economic conditions, and the figure below shows that pine pulpwood stumpage prices in the catchment area have closely followed the Dow Jones Industrial Average (DJIA) since 2000. Pine pulpwood prices and the DJIA did deviate from one another in 2018 and 2019. However, this deviation was due to excess supply (salvage wood) created by Hurricane Michael.



Source: US Federal Reserve Bank, TimberMart-South

- Weather. Weather trends also impact timber prices in this catchment area and across the South. However, these trends are much more seasonal in nature and affect short-term price movements. In this region, wet conditions typically persist throughout the winter (in the 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).



Source: TimberMart-South

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

The figure on the preceeding page shows quarterly average pine pulpwood stumpage prices in the Georgia catchment from 1Q 2000 through 1Q 2020, with seasonal weather-related price spikes highlighted in red. Note that of the 10 seasonal spikes identified in that figure, eight (80%) occurred in either the 1st or 4th quarter of the year.

- Competition. In the Georgia catchment area, demand for pine pulpwood (the primary roundwood product consumed for pellet production) is largely driven by the pulp/paper industry. Specifically, there are seven pine pulpwood-consuming pulp/paper mills located along the Atlantic Coast between Jacksonville FL and Savannah GA, which together consume an estimated 6-8 million tons of roundwood (pulpwood) annually. Competition is inherently high as a result of this high level of mill concentration, especially with the Atlantic Ocean serving as a barrier to the east, leading to increased pine pulpwood prices (relative to the western portion of the catchment area as well as most other markets across the region).

  For a more detailed look at how mill concentration and mill competition impact pine pulpwood prices in the Georgia catchment area, see Annex 1.

5. Forest Management Practices Assessment

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

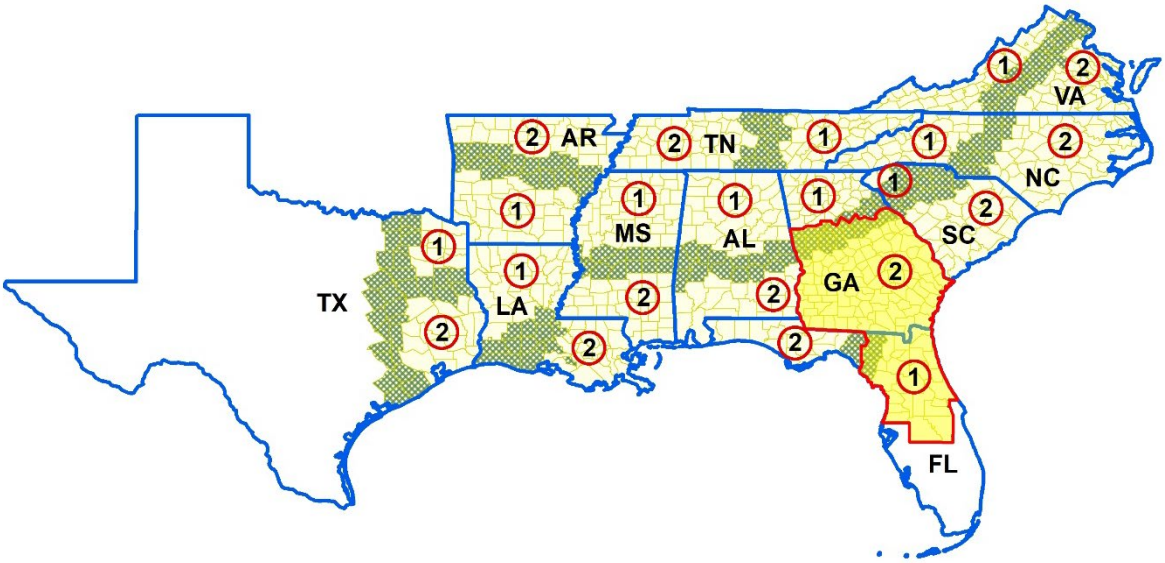
5.1 TimberMart-South Harvest Trends

The TimberMart-South (TMS) sales database includes over 110,000 unique timber sales that have occurred throughout the TMS 11-state region since 2000. In addition to providing details regarding timber prices (by product), these reported sales include information regarding date of sale, location, sale volume, sale size (acres), 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 Georgia catchment area is located in two different TMS regions: Georgia Region 2 and Florida Region 1 (see highlighted portion in Figure 21 below). Data and trends for this 2-region area (denoted 'southeast Georgia market' in this section) have been provided by TimberMart-South and are intended to be representative of the catchment area.

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

***Figure 21**. TimberMart-South Region Map*



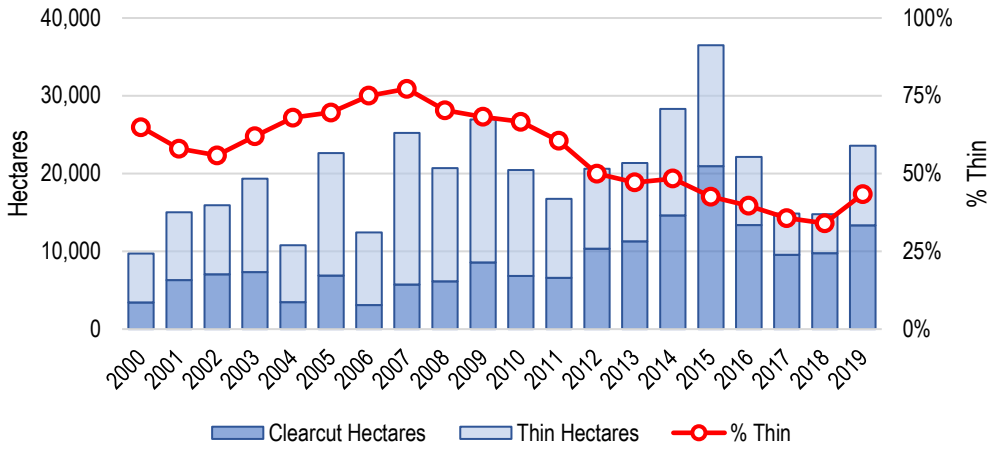
5.1.1 *Total Sale Area*

In the southeast Georgia market, the total area of all timber sales reported to TMS has averaged roughly 19,900 hectares per year since 2000 (see Figure 22). However, more importantly, TMS data shows a shift in the distribution of reported sale area by harvest type (clearcut vs. thinning) in comparing trends from 2000-2010 versus those from 2012-2019.

Clearcuts and thinnings are the two major types of harvests that occur in the region, both of which are long-standing, widely used methods of harvesting timber. In the southeast Georgia market, thinnings constituted a majority of the total reported harvest area through the 2000s. Specifically, thinnings accounted for 67% of total reported harvest area from 2000-2010 but only 43% of total reported harvest area since 2012.

Ultimately, the southeast Georgia (and northeast Florida) market is driven to a large degree by the pulp/paper industry, with a significant portion of the timber management in this area focused on short pulpwood rotations (to take advantage of the historically strong pulpwood markets) that do not include thinnings. The reduced thinning area (relative to clearcut area) since around 2012 is also a function of the relative weakness of sawtimber markets in this area. For example, when pine sawtimber prices are strong, thinnings become more prevalent – to promote sawtimber production. However, since pulpwood markets are strong (and sawtimber markets are relatively weak), the focus appears to have shifted to short rotation timber management with less thinnings.

***Figure 22**. Total Reported Sale Area by Harvest Type (2000 - 2019)*



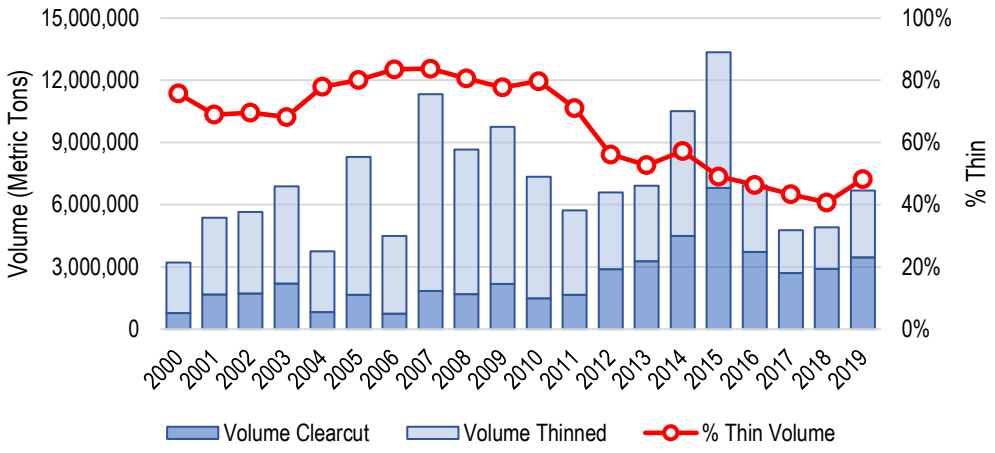
**Please note that these values do not represent the actual area of all timber harvested in this market, but rather the total number of hectares reported to TimberMart-South by its contributing reporters.*

5.1.2 *Total Sale Volume*

In the southeast Georgia market, the total volume of all timber sales reported to TMS has averaged approximately 7.1 million metric tons per year since 2000 (see Figure 23). However, as with reported sale area, what's of specific interest are those trends, identified by data reported to TMS, as they relate to changes in harvest volume by specific harvest type.

Specifically, examination of total sale volume reported to TMS by harvest type shows the proportion of total volume attributed to thinnings decreased substantially from 2010-2012. Specifically, thinnings accounted for 78% of total reported harvest volume in this market from 2000-2010, compared to 50% since 2011. Note that the increased distribution of volume thinned (relative to volume clearcut) coincided with strong sawtimber markets in the early to mid-2000s. Specifically, pine sawtimber stumpage prices averaged more than $45 per ton in this market from 2000-2006, and this high price led many landowners to focus on sawtimber production (which utilizes thinnings). However, since 2008, pine sawtimber stumpage prices have averaged less than $30 per ton in this market. So, given these relatively weak pine sawtimber prices, the focus shifted more towards short pulpwood rotations – a type of timber management that generally does not utilize thinnings.

***Figure 23**. Total Reported Sale Volume by Harvest Type (2000 - 2019)*



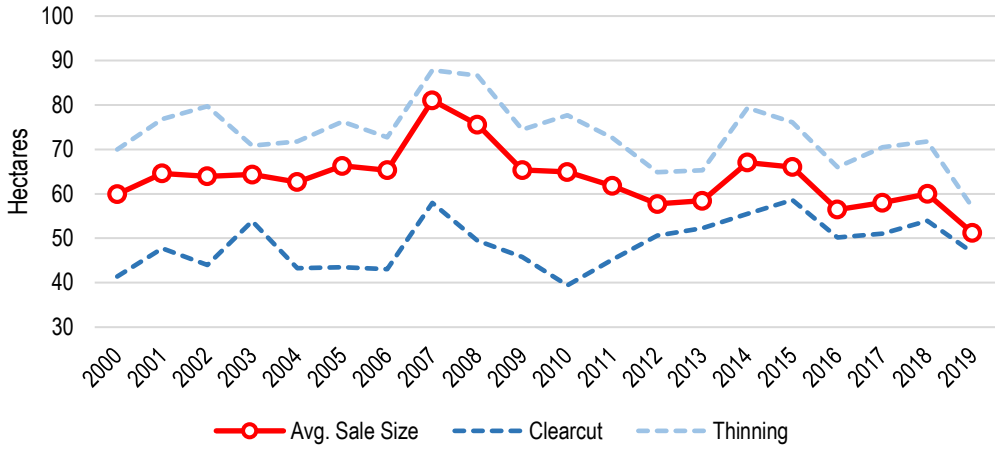
**Please note that these values do not represent the actual volume of all timber harvested in this market, but rather the total volume of harvested timber reported to TimberMart-South by its contributing reporters.*

5.1.3 *Average Sale Size*

The average size of timber sales reported to TMS in the southeast Georgia market averaged approximately 64 hectares from 2000-2019. TimberMart-South data also shows that thinnings have averaged 51% (+24 hectares) larger than clearcuts since 2000, with thinnings averaging 73 hectares in size compared to 49 hectares for clearcuts. However, we'd like to note that the gap between average clearcut size and average thinning size has also narrowed in this market since 2012. Specifically, thinnings averaged 66% (+30 hectares) larger than clearcuts from 2000-2010 but only 31% (+16 hectares) larger than clearcuts since 2012.

In general, clearcuts tend to be smaller than thinnings in size due to capital requirements for the logger/wood buyer. To elaborate, clearcuts typically remove more timber volume per acre (and higher-value timber products) compared to thinnings. So, for example, given the same amount of capital, a wood buyer/logger can purchase a 50-hectare tract to be clearcut or a 75-hectare tract to be thinned. Also, loggers/wood buyers typically prefer larger tracts for thinning because it allows them to take advantage of economies of scale. Furthermore, timberland owners and managers that adhere to Sustainable Forestry Initiative (SFI) standards must limit the size of cleacuts to roughly 50 hectares or less.

***Figure 24**. Average Reported Sale Size by Harvest Type (2000 - 2019)*



6. Market Trends, Analysis, & Outlook

The following section provides an examination and assessment of forest market trends in the Georgia catchment area since 2000, as well as a market outlook through 2022 which details anticipated changes in wood demand and how these changes are likely to impact this market over the next several years.

6.1 Market Trends & Analysis

A key aspect of this analysis includes assessing and identifying any links or relationships between biomass-related wood demand and other market changes (i.e. forest area, inventory, raw material prices, etc.) in the catchment area, particularly since Georgia Biomass started up in 2011. As such, this section will begin with an assessment of annual wood demand.

6.1.1 *Wood Demand*

Annual wood demand[6] in the Georgia catchment area held relatively steady, increasing modestly (+5% total; +0.3% per year average) from an estimated 19.3 million metric tons in 2000 to 20.2 million metric tons in 2014. Over the three years that followed, total demand increased at a much more rapid pace, increasing an average of 2.5% per year (+8% total) to 21.7 million metric tons in 2017. However, in 2018, total demand increased to nearly 23.6 million metric tons, up 8% (+1.8 million metric tons) from 2017. Note that this increase was due to Hurricane Michael, a Category 5 hurricane that impacted the Florida Panhandle before moving inland to the northeast and directly through the Georgia catchment area.

***Table 22**. Georgia Catchment Area - Annual Wood Demand (2000-2018)*

Year	Softwood Sawlogs	Softwood Pulpwood	Hardwood Sawlogs	Hardwood Pulpwood	Total Wood Demand
			(Metric Tons)		
2000	8,881,962	7,038,995	1,214,926	2,125,358	19,261,240
2001	8,699,802	6,923,757	1,261,687	2,064,373	18,949,619
2002	8,425,676	7,133,116	1,286,969	1,853,848	18,699,608
2003	8,151,063	7,342,352	1,311,467	1,635,399	18,440,280
2004	8,515,928	7,293,763	1,332,330	1,516,676	18,658,697
2005	8,837,530	7,493,640	1,340,032	1,420,210	19,091,412
2006	8,710,917	8,088,088	1,315,450	1,326,658	19,441,112
2007	8,735,918	8,856,979	1,476,897	1,383,165	20,452,958
2008	8,041,562	8,779,404	1,267,612	1,251,610	19,340,188
2009	7,709,116	9,105,780	1,240,644	1,269,466	19,325,004
2010	7,763,789	9,751,653	1,119,346	1,185,066	19,819,854
2011	7,928,762	10,475,948	1,106,606	1,261,323	20,772,639
2012	7,857,939	10,208,707	866,752	1,050,959	19,984,357
2013	8,096,834	10,230,658	845,773	1,060,441	20,233,707
2014	8,253,580	10,069,935	762,695	1,066,536	20,152,746
2015	8,824,579	9,916,182	872,979	1,158,658	20,772,399
2016	9,471,297	9,826,343	826,573	1,102,853	21,227,067
2017	9,964,205	9,717,278	851,350	1,189,118	21,721,951
2018	10,659,387	10,878,622	874,804	1,142,856	23,555,669

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

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

***Figure 25**. Georgia Catchment Area – Total Annual Wood Demand (2000-2018)*

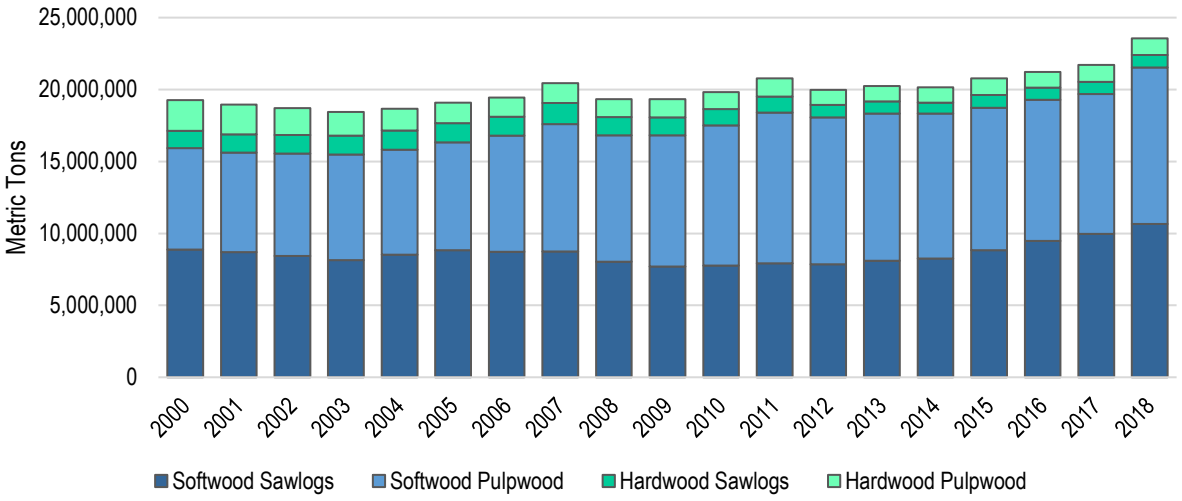
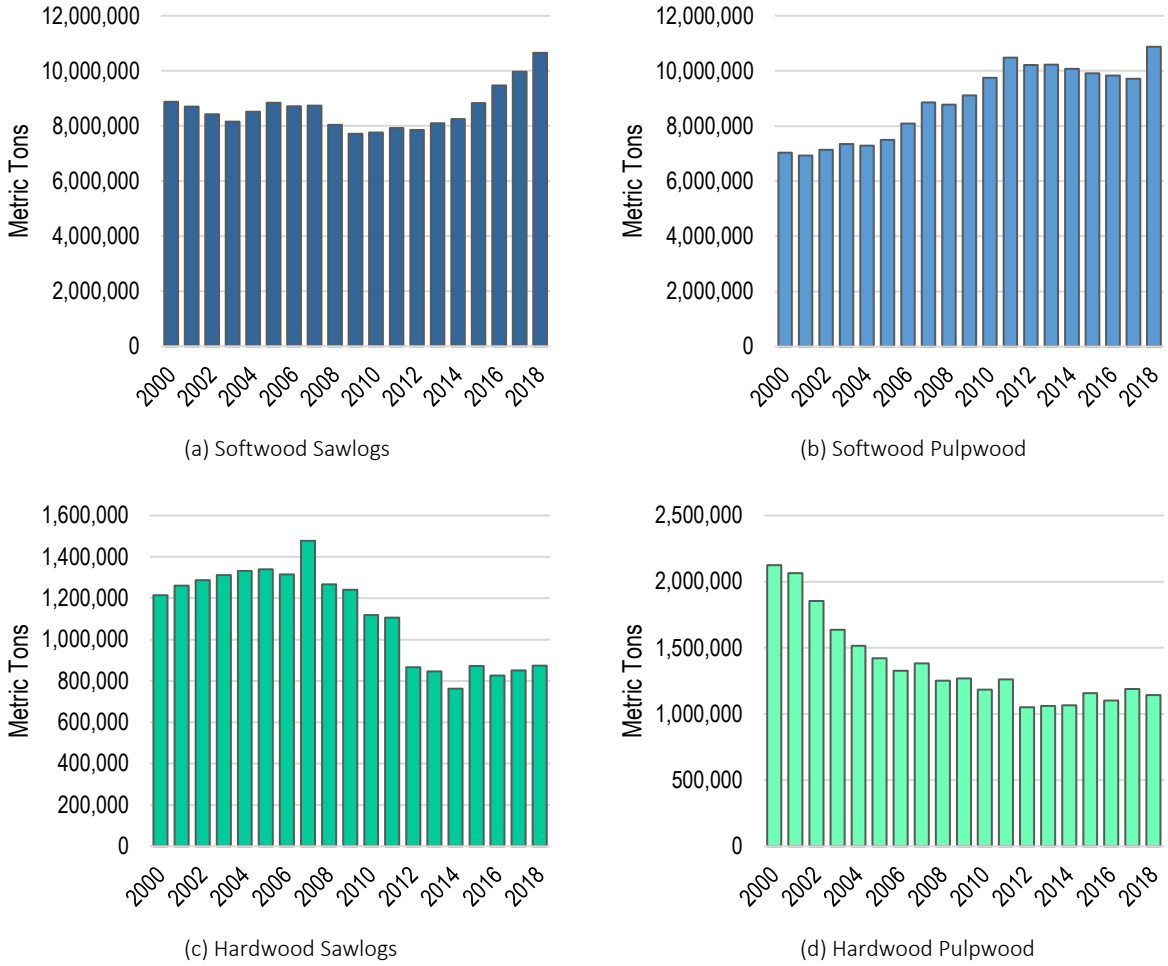


***Figure 26**. Georgia Catchment Area – Annual Wood Demand by Major Species & Product (2000-2018)*



6.1.1.1 Biomass Demand & Total Pulpwood Demand

Biomass demand is defined as softwood and hardwood pulpwood (roundwood) consumed by pellet or other bioenergy facilities.

Presently, there are seven major wood pellet mills operating within the Georgia catchment area, and an additional four pellet mills operating within close proximity to the catchment area. However, only four of these 11 mills utilize roundwood for wood pellet production (the other seven mills utilize residuals only):

Mill Name	Location	Feedstock Type	Startup
Briar Creek Pellets	Sylvania GA	Residuals Only	2001
Rockwood Pellets	The Rock GA	Residuals Only	2006
Appling County Pellets (Fram)	Baxley GA	Residuals Only	2008
Enviva Cottondale	Cottondale FL	Roundwood + Residuals	2008
Georgia Biomass	Waycross GA	Roundwood + Residuals	2011
Ridgeland Pellets	Ridgeland SC	Residuals Only	2011
Varn Wood Products	Hoboken GA	Residuals Only	2012
Hazlehurst Wood Pellets (Fram)	Hazlehurst GA	Roundwood + Residuals	2014
LJR Forest Products	Swainsboro GA	Residuals Only	2014
Telfair Forest Products (Fram)	Lumber City GA	Residuals Only	2014
Archer Forest Products (Fram)	Nahunta GA	Roundwood + Residuals	2015*

*Commissioned in 2015 as E-Pellets; shutdown in 2016; restarted by Fram in 2019

Enviva Cottondale was the first of these four roundwood-consuming pellet mills to startup, with roundwood (biomass) demand attributed to the Georgia catchment area estimated at roughly 20,000 metric tons in 2008. Total catchment area biomass demand increased to roughly 800,000 metric tons in 2011 with the startup of Georgia Biomass, and to nearly 1.5 million metric tons in 2015 (following Hazlehurst Wood Pellets' startup in 2014 and Archer FP's startup in 2015). The shutdown of E-Pellets reduced total biomass demand to between 1.2-1.3 million metric tons annually from 2016-2018. However, demand increased to nearly 1.6 million metric tons in 2019, following Fram's purchase and restart of the former E-Pellets mill.

Note that biomass demand is predominantly softwood (pine), with softwood biomass demand accounting for 94% of total biomass demand in the Georgia catchment area since 2008 (compared to 6% hardwood biomass demand[7]). Also, biomass-related pulpwood demand accounted for only 2% of total pulpwood demand in the Georgia catchment area from 2008-2011, compared to 12% from 2012-2019. For a detailed breakdown of biomass and non-biomass-related pulpwood demand in the catchment area since 2000, see Table 23 on the following page.

[7] Georgia Biomass is responsible for over 99% of total bioenergy-related hardwood pulpwood purchased in the Georgia catchment area since 2012. Hardwood pulpwood (roundwood) purchases by Fram have totaled less than 6,400 metric tons overall, or less than 1% of total hardwood biomass demand since 2012.

***Table 23**. Georgia Catchment Area - Biomass Demand & Total Pulpwood Demand (2000-2019)*

	Biomass Demand			Other Pulpwood Demand			Total Pulpwood Demand		
Year	Softwood	Hardwood	Total	Softwood	Hardwood	Total	Softwood	Hardwood	Total
					(Metric Tons)				
2000	-	-	-	7,038,995	2,125,358	9,164,353	7,038,995	2,125,358	9,164,353
2001	-	-	-	6,923,757	2,064,373	8,988,130	6,923,757	2,064,373	8,988,130
2002	-	-	-	7,133,116	1,853,848	8,986,964	7,133,116	1,853,848	8,986,964
2003	-	-	-	7,342,352	1,635,399	8,977,750	7,342,352	1,635,399	8,977,750
2004	-	-	-	7,293,763	1,516,676	8,810,439	7,293,763	1,516,676	8,810,439
2005	-	-	-	7,493,640	1,420,210	8,913,850	7,493,640	1,420,210	8,913,850
2006	-	-	-	8,088,088	1,326,658	9,414,745	8,088,088	1,326,658	9,414,745
2007	-	-	-	8,856,979	1,383,165	10,240,144	8,856,979	1,383,165	10,240,144
2008	18,979	-	18,979	8,760,426	1,251,610	10,012,035	8,779,404	1,251,610	10,031,014
2009	25,305	-	25,305	9,080,475	1,269,466	10,349,940	9,105,780	1,269,466	10,375,245
2010	33,741	-	33,741	9,717,913	1,185,066	10,902,977	9,751,653	1,185,066	10,936,718
2011	802,817	-	802,817	9,673,132	1,261,323	10,934,455	10,475,948	1,261,323	11,737,271
2012	1,334,293	531	1,334,824	8,874,414	1,050,428	9,924,842	10,208,707	1,050,959	11,259,666
2013	1,449,289	1,086	1,450,375	8,781,370	1,059,355	9,840,725	10,230,658	1,060,441	11,291,099
2014	1,387,583	13,211	1,400,794	8,682,352	1,053,324	9,735,676	10,069,935	1,066,536	11,136,471
2015	1,405,002	90,621	1,495,622	8,511,181	1,068,038	9,579,219	9,916,182	1,158,658	11,074,841
2016	1,155,998	88,275	1,244,273	8,670,345	1,014,578	9,684,923	9,826,343	1,102,853	10,929,196
2017	1,067,707	142,123	1,209,830	8,649,572	1,046,994	9,696,566	9,717,278	1,189,118	10,906,396
2018	1,100,947	142,961	1,243,908	9,777,675	999,895	10,777,570	10,878,622	1,142,856	12,021,479
2019	1,371,567	200,865	1,572,432	9,191,015	976,345	10,167,360	10,562,582	1,177,210	11,739,792

Source: USDA-US Forest Service; TimberMart-South; Georgia Biomass; Fram Renewable Fuels
**Projected*

Figure 27. Georgia Catchment Area – Softwood Pulpwood Demand (2000-2019)

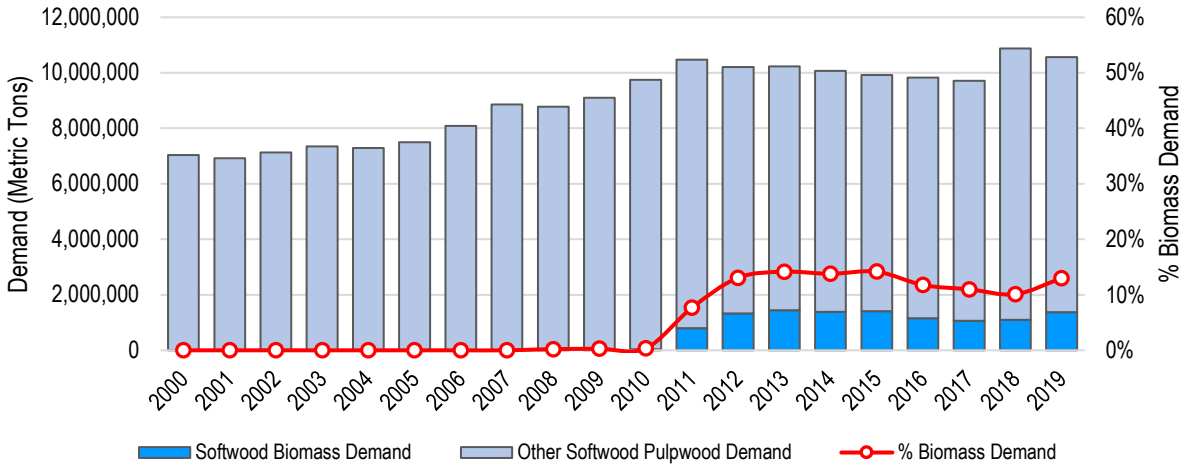


Figure 28. Georgia Catchment Area – Hardwood Pulpwood Demand (2000-2019)

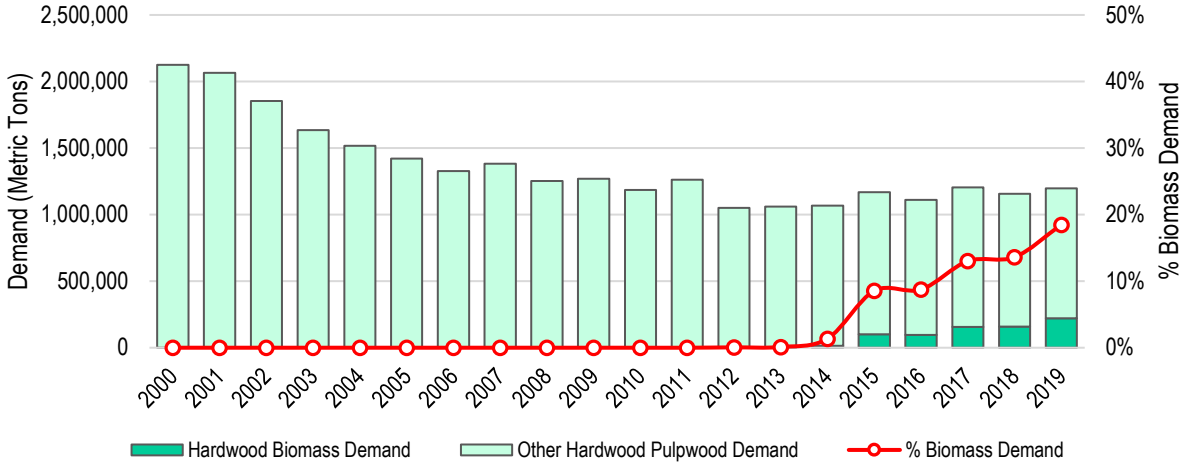
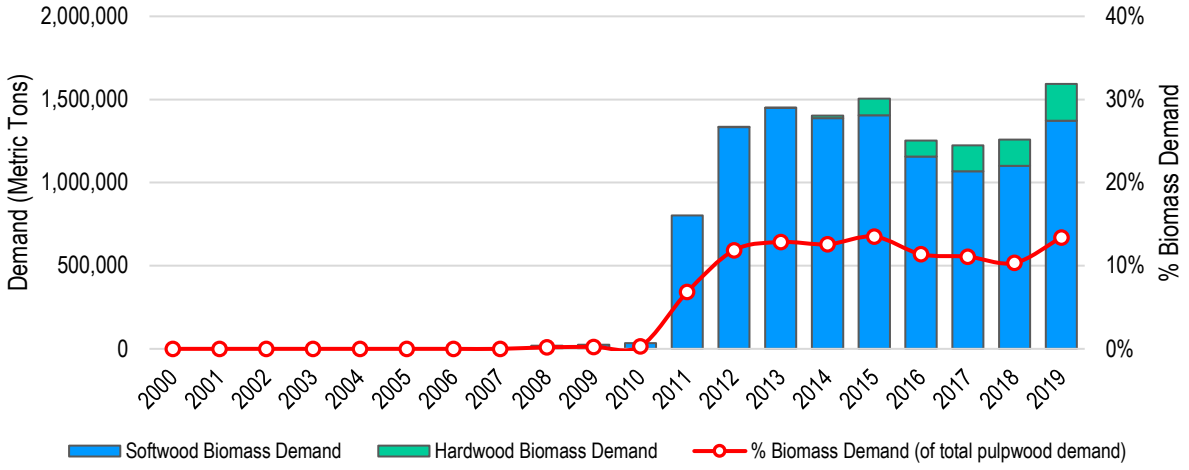


Figure 29. Georgia Catchment Area – Total Biomass Demand (2000-2019)



6.1.2 *Changes in Land Area & Use*

Notable changes in land area occurred in the Georgia catchment area from 2000-2018, including a 1.5% decrease in forestland and a 5.5% decrease in land in farms (i.e. cropland, woodland, and pastureland). Also, urban areas or land classified as having other uses more than quadrupled from 2000 to 2018.

According to the USDA, total forestland decreased from an estimated 4,226,157 hectares in 2000 to 4,161,035 hectares in 2018, or a net decrease of 65,122 hectares (-1.5%) over this 18-year period. Over this same period, land in farms decreased a total of 93,192 hectares, with woodland and pastureland decreasing a combined 191,629 hectares (-19%). However, cropland increased an estimated 98,436 hectares (+14%) from 2000-2018.

Urban areas and land classified as having other uses increased an estimated 158,315 hectares from 49,311 hectares in 2000 to 207,627 hectares in 2018. However, note that urban and other lands have held relatively steady and averaged roughly 200,000 hectares since 2016. See Table 24 for details.

***Table 24**. Georgia Catchment Area – Land Area by Land Classification & Use (2000-2018)*

	Forestland			*Land in Farms*					
Year	Timberland	Other Forestland	Total	Cropland	Woodland	Pastureland	Total	Urban & Other Land Uses	Total Land Area
					(Hectares)				
2000	4,130,223	95,934	4,226,157	690,468	666,624	328,582	1,685,674	49,311	5,961,143
2001	4,128,917	106,539	4,235,457	694,347	660,222	323,733	1,678,301	47,385	5,961,143
2002	4,116,242	117,592	4,233,835	698,275	653,795	318,859	1,670,929	56,379	5,961,143
2003	4,109,723	133,784	4,243,508	707,361	641,845	309,509	1,658,715	58,921	5,961,143
2004	4,094,276	154,466	4,248,743	716,703	629,765	300,033	1,646,501	65,899	5,961,143
2005	4,090,458	167,768	4,258,226	726,313	617,550	290,424	1,634,287	68,629	5,961,143
2006	4,104,437	160,793	4,265,230	736,205	605,193	280,676	1,622,073	73,839	5,961,143
2007	4,109,927	161,015	4,270,942	746,393	592,686	270,781	1,609,860	80,341	5,961,143
2008	4,113,205	149,932	4,263,137	751,952	592,907	258,451	1,603,310	94,696	5,961,143
2009	4,111,443	145,232	4,256,675	757,721	593,194	245,846	1,596,760	107,708	5,961,143
2010	4,111,683	149,085	4,260,768	763,711	593,547	232,952	1,590,211	110,164	5,961,143
2011	4,110,855	152,135	4,262,990	769,934	593,973	219,755	1,583,661	114,492	5,961,143
2012	4,103,158	147,010	4,250,168	776,401	594,472	206,238	1,577,112	133,863	5,961,143
2013	4,080,632	148,147	4,228,779	778,676	593,424	207,807	1,579,906	152,457	5,961,143
2014	4,068,722	155,121	4,223,843	780,950	592,377	209,374	1,582,701	154,599	5,961,143
2015	4,046,377	152,206	4,198,583	783,223	591,330	210,942	1,585,495	177,065	5,961,143
2016	4,033,258	148,923	4,182,181	785,496	590,286	212,508	1,588,290	190,672	5,961,143
2017	4,008,868	161,825	4,170,693	787,768	589,242	214,074	1,591,084	199,365	5,961,143
2018	3,995,028	166,007	4,161,035	788,904	588,720	214,857	1,592,482	207,627	5,961,143

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

6.1.3 *Changes in Forest Area (Timberland)*

According to the US Forest Service, the total area of timberland in the Georgia catchment area experienced a net decrease of 135,195 hectares (-3%) from 2000-2018, the latest available, decreasing from 4,130,223 to 3,995,028 hectares over this 18-year period. Specifically, total timberland area held relatively steady through the 2000s and early 2010s, averaging roughly 4,111,000 hectares from 2000-2011. However, from 2011-2018, total Georgia catchment area timberland declined an estimated 115,827 hectares, or a 2.8% decrease over this period.

Note that while the total area of timberland has decreased in the catchment area since 2000, planted pine timberland (the predominant supplier of pine pulpwood consumed by the pulp/paper and bioenergy industries in this market) increased an estimated 51,195 hectares (+3%) from 2000-2018. This increase in planted pine timberland coincided with a simultaneous 52,490-hectare decrease in natural pine timberland – suggesting that, during this period, much of the natural pine timberland was converted to planted pine timberland following final harvest.

***Table 25**. Georgia Catchment Area - Timberland Area by Stand Origin (2000-2018)*

	Planted		Naturally Regenerated			
Year	Pine	Hardwood	Pine	Hardwood	Mixed Pine-Hardwood	Total
			(Hectares)			
2000	1,570,220	152,238	713,916	1,429,026	264,823	4,130,223
2001	1,571,945	155,408	714,361	1,417,913	269,291	4,128,917
2002	1,577,165	154,228	711,684	1,403,577	269,588	4,116,242
2003	1,598,899	160,689	679,952	1,401,432	268,751	4,109,723
2004	1,618,131	163,849	647,802	1,389,448	275,046	4,094,276
2005	1,637,933	154,580	636,695	1,377,489	283,762	4,090,458
2006	1,657,528	145,602	640,366	1,359,198	301,743	4,104,437
2007	1,658,020	142,165	635,582	1,353,166	320,994	4,109,927
2008	1,672,692	139,588	643,963	1,341,362	315,600	4,113,205
2009	1,691,641	133,828	637,298	1,326,017	322,659	4,111,443
2010	1,681,521	137,732	629,332	1,329,541	333,556	4,111,683
2011	1,687,696	137,823	612,436	1,336,240	336,660	4,110,855
2012	1,682,046	136,226	630,533	1,329,439	324,913	4,103,158
2013	1,665,464	127,149	640,707	1,325,861	321,451	4,080,632
2014	1,656,549	130,399	630,659	1,329,886	321,228	4,068,722
2015	1,645,219	121,009	644,413	1,332,087	303,650	4,046,377
2016	1,625,410	121,842	640,419	1,348,343	297,243	4,033,258
2017	1,629,673	113,137	649,735	1,316,978	299,345	4,008,868
2018	1,621,415	114,026	661,426	1,311,344	286,817	3,995,028

Source: USDA-US Forest Service

***Figure 30**. Georgia Catchment Area - Timberland Area by Year (2000 – 2018)*

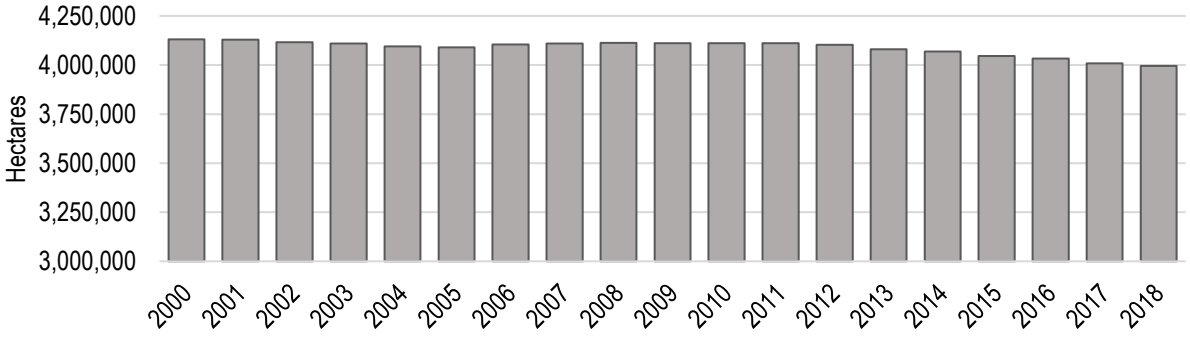
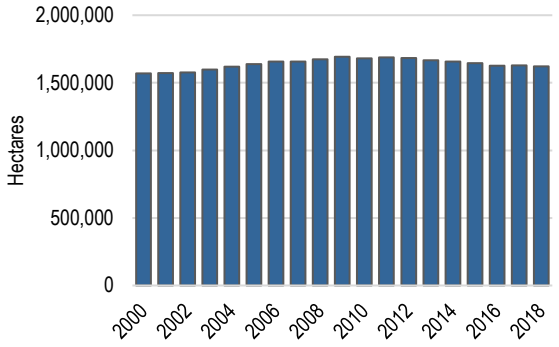
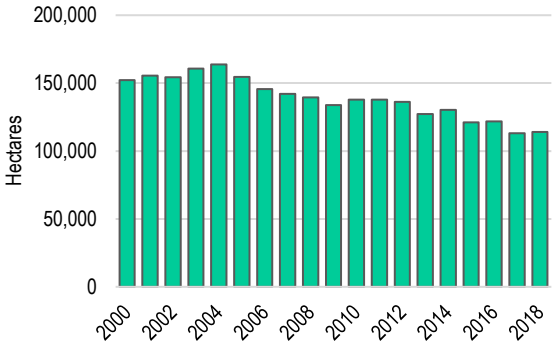


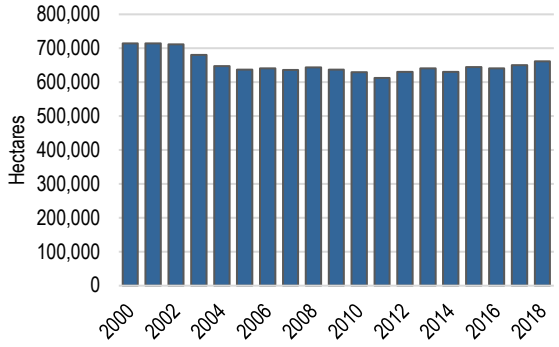
***Figure 31**. Georgia Catchment Area – Timberland Area by Stand Origin (2000-2018)*



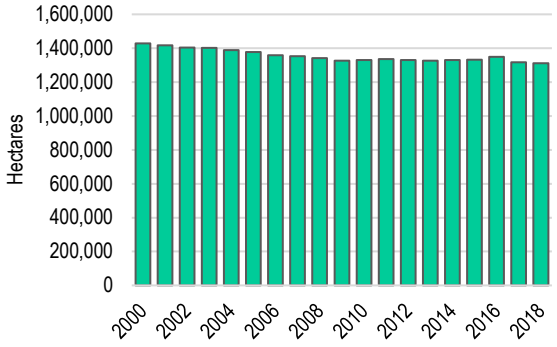
(a) Planted Pine



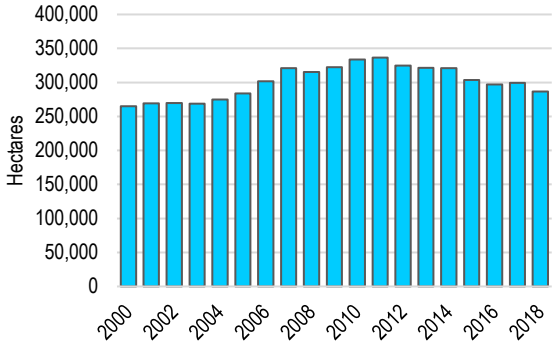
(b) Planted Hardwood



(c) Naturally Regenerated Pine



(d) Naturally Regenerated Hardwood



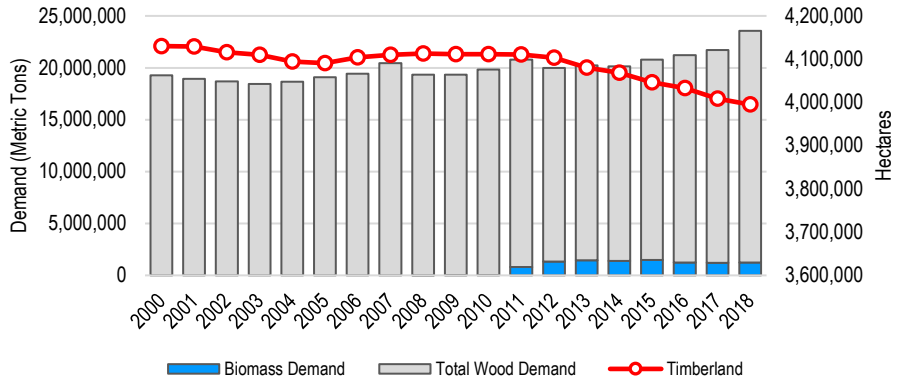
(e) Naturally Regenerated Mixed Pine-Hardwood

Correlation Analysis: *Biomass Demand vs. Timberland*

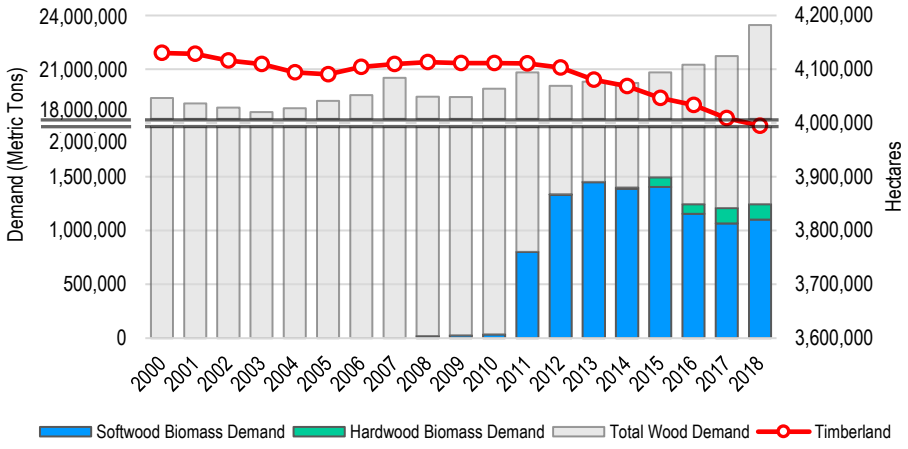
Figure 32 provides a side-by-side comparison of both biomass demand and total wood demand versus timberland area in the catchment area from 2000-2018. In comparing changes in biomass demand to changes in timberland area, no noticeable relationship appears evident, as total biomass demand has remained relatively constant since 2012 while the total area of timberland has steadily declined. Ultimately, correlation analysis identified a moderately strong negative correlation (correlation coefficient=-0.68) between biomass demand and timberland area from 2000-2018.

Looking again at the figure below, notice that timberland area appeared to closely track total wood demand through the 2000s. However, since 2010, the two have moved in opposite directions. Ultimately, correlation analysis identified a strong negative relationship (correlation coefficient=-0.84) between total wood demand and timberland area from 2000-2018. However, we would like to note that a positive relationship, albeit weak, was found between total wood demand and planted pine timberland – the primary forest type that supports the forest products industry in this catchment area.

***Figure 32**. Georgia Catchment Area – Biomass Demand & Total Wood Demand vs. Timberland Area (2000-2018)*



(a) Total Wood Demand vs. Timberland Hectares



(b) Biomass Demand vs. Timberland Hectares

Ultimately, changes in timberland area appear to be more closely linked to both the strength of sawtimber markets as well as the alternatives provided by agriculture. Specifically, a positive correlation was found between timberland area and pine sawtimber stumpage price (correlation coefficient=0.46) while strong negative correlations were found between cropland and both timberland (correlation coefficient=-0.70) and pine sawtimber stumpage price (correlation coefficient=-0.90) from 2000-2018. This suggests that losses in timberland (since 2011), to some degree, have been impacted by both of these items, as weak pine sawtimber stumpage prices have made conversion and investment in agriculture more appealing to landowners. Furthermore, these findings also support the case that forest management decisions are not driven by biomass markets.

***Table 26**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Timberland Area (2000-2018)*

	Softwood Biomass Demand	*Other Softwood Pulpwood Demand*	*Total Softwood Pulpwood Demand*	*Pine Timberland*	*Total Timberland*
Softwood Biomass Demand	1				
Other Softwood Pulpwood Demand	0.48	1			
Total Softwood Pulpwood Demand	0.80	0.91	1		
Pine Timberland	-0.04	0.49	0.32	1	
Total Timberland	-0.68	-0.40	-0.59	0.39	1

	Hardwood Biomass Demand	*Other Hardwood Pulpwood Demand*	*Total Hardwood Pulpwood Demand*	*Hardwood Timberland*	*Total Timberland*
Hardwood Biomass Demand	1				
Other Hardwood Pulpwood Demand	-0.48	1			
Total Hardwood Pulpwood Demand	-0.36	0.99	1		
Hardwood Timberland	-0.57	0.93	0.90	1	
Total Timberland	-0.94	0.66	0.56	0.67	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Timberland*
Softwood Biomass Demand	1			
Hardwood Biomass Demand	0.56	1		
Total Biomass Demand	0.99	0.61	1	
Total Timberland	-0.68	-0.94	-0.72	1

6.1.4 *Changes in Timber Inventory*

Timber inventory data for the Georgia catchment area was provided by the US Forest Service - Forest Inventory & Analysis (FIA) program from 2000 through 2018[8], the most current available. According to FIA estimates, total growing stock inventory on timberland in the Georgia catchment area increased from 328 million m^3 in 2000 to 391 million m^3 in 2018, or a net increase of over 63 million m^3 (+19% total; +1.0% per year average) over this period.

Table 27 below (as well as Figures 33 and 34 on the following page) provides a breakdown of timber inventory in the catchment area by major timber product from 2000-2018. Note that inventories of pine sawtimber and pine chip-n-saw both increased while inventories of pine pulpwood decreased slightly from 2000-2018. Inventories of hardwood sawtimber and hardwood pulpwood declined in the early 2000s, but both have held relatively stable (increased slightly) since.

***Table 27**. Georgia Catchment Area - Timber Inventory by Major Timber Product (2000-2018)*

	Softwood			Hardwood		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(000 Cubic Meters)			
2000	81,422	52,939	80,774	61,432	51,466	328,034
2001	81,554	52,882	82,076	59,422	49,918	325,852
2002	82,674	53,193	83,101	59,822	48,879	327,669
2003	84,379	54,183	83,320	57,566	47,036	326,484
2004	85,248	56,520	84,537	57,761	46,449	330,516
2005	87,482	59,812	86,058	56,917	44,699	334,969
2006	88,678	61,849	87,680	59,871	46,542	344,619
2007	87,539	61,781	86,906	57,804	45,578	339,610
2008	90,556	63,554	89,012	58,591	45,161	346,874
2009	92,130	64,212	87,797	57,251	44,753	346,143
2010	96,145	65,647	86,036	57,692	45,696	351,216
2011	98,400	66,574	84,065	57,043	45,354	351,436
2012	102,399	69,327	83,998	56,953	45,329	358,005
2013	107,423	70,949	82,834	55,792	44,249	361,248
2014	110,914	72,808	82,837	55,873	43,475	365,908
2015	114,790	73,102	79,343	55,204	41,892	364,331
2016	118,035	72,359	76,829	56,938	42,936	367,097
2017	124,275	74,623	76,359	59,797	44,069	379,122
2018	132,724	75,216	74,939	62,644	45,809	391,331

Source: USDA - US Forest Service

[8] US Forest Service FIA data for those areas located in Florida were only available through 2017. Estimates for 2018 have been included and are based on historical trends and a local area inventory model.

***Figure 33**. Georgia Catchment Area - Timber Inventory by Major Timber Product (2000-2018)*

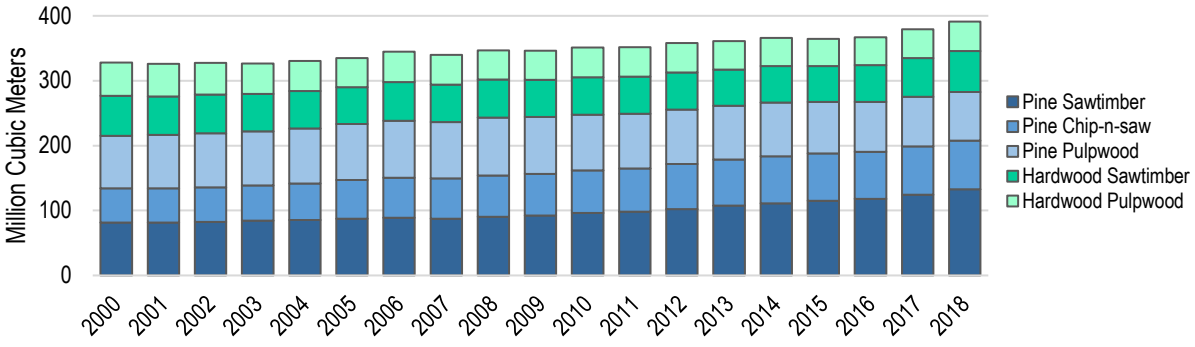
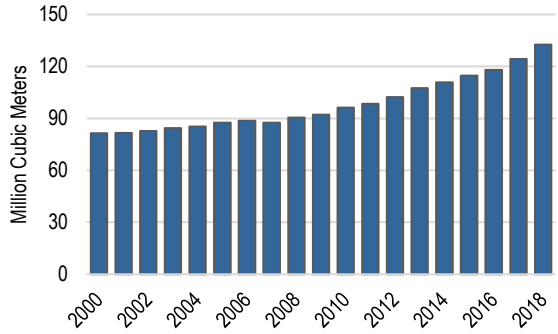
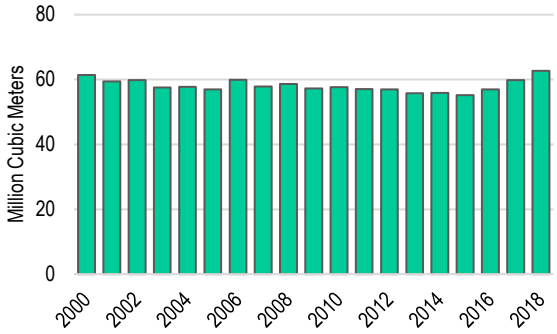


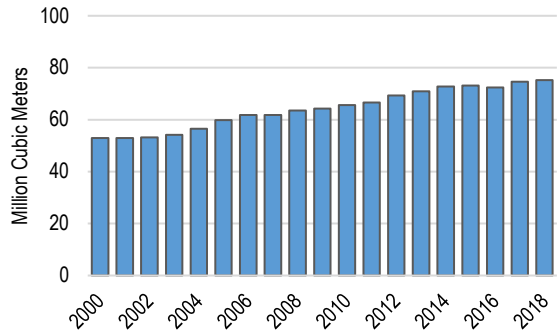
***Figure 34**. Georgia Catchment Area - Timber Inventory by Major Timber Product (2000-2018)*



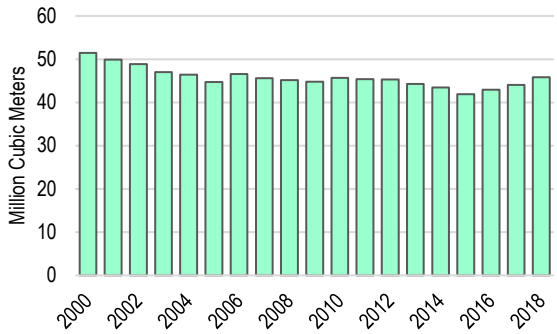
(a) Pine Sawtimber



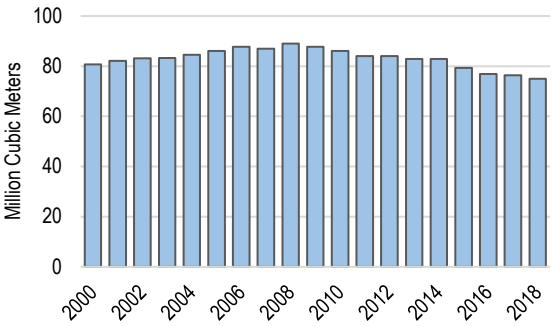
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

6.1.4.1 *Diameter Class Distribution*

Total growing stock inventory on timberland increased from 328 million m^3 in 2000 to 391 million m^3 in 2018, or a net increase of over 63 million m^3 (+19% total; +1.0% per year average). Over this period, there were also some minor changes in the distribution of growing stock inventory by diameter class. Specifically, softwood and hardwood growing stock inventory both increased in average diameter.

Table 28 below provides a comparison of growing stock inventory estimates in the catchment area by major species group and diameter class in 2000, 2009, and 2018. Specifically, USFS data shows that in both 2000 and 2009, approximately 87% of softwood growing stock inventory was less than 17 inches in diameter, with softwood inventory averaging 11.5 and 11.6 inches in diameter, respectively, in these two periods. However, in 2018, approximately 83% of softwood inventory was 17 inches or less in diameter, with softwood inventory averaging 12.5 inches in diameter.

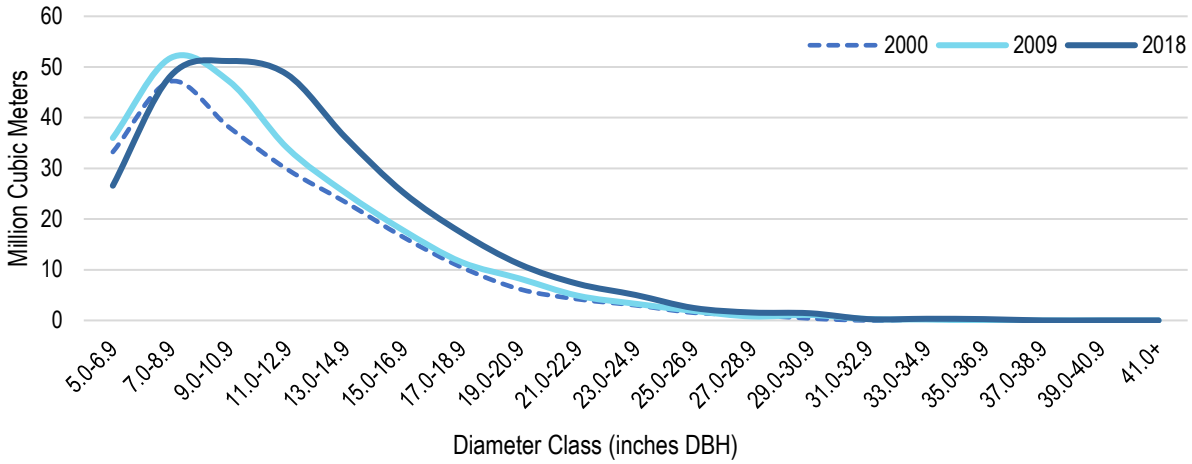
The historic distributions of hardwood growing stock inventory by diameter class show 84% of hardwood inventory was less than 19 inches in diameter in 2000, falling to 80% within these same parameters in 2009 and to 79% in 2018. Hardwood growing stock inventory averaged an estimated 13.7 inches in diameter in 2000, compared to 14.2 inches in 2009 and 14.3 inches in 2018.

***Table 28**. Georgia Catchment Area - Timber Inventory by Major Species Group & Diameter Class (2000, 2009, & 2018)*

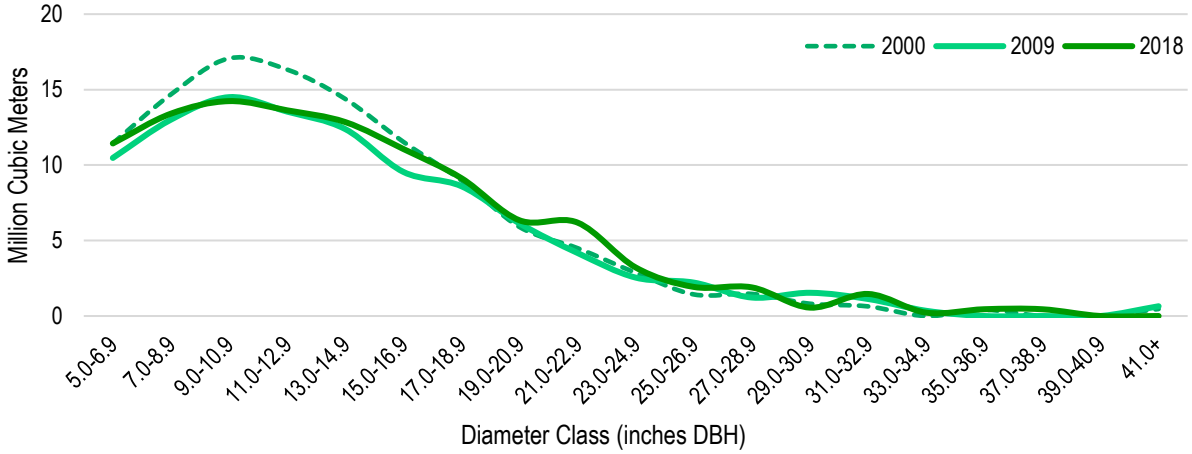
Diameter Class	*Softwood*			*Hardwood*			*Total*		
(inches DBH)	2000	2009	2018	2000	2009	2018	2000	2009	2018
					(000 Cubic Meters)				
5.0-6.9	33,230	35,989	26,578	11,441	10,472	11,433	44,671	46,461	38,011
7.0-8.9	47,161	51,808	48,303	14,684	13,010	13,406	61,844	64,819	61,709
9.0-10.9	38,110	47,190	51,172	17,070	14,500	14,237	55,180	61,690	65,409
11.0-12.9	29,825	34,044	48,531	16,328	13,542	13,627	46,152	47,586	62,159
13.0-14.9	23,359	25,215	36,145	14,384	12,385	12,850	37,742	37,600	48,995
15.0-16.9	16,425	17,764	25,240	11,540	9,549	11,067	27,965	27,313	36,307
17.0-18.9	10,501	11,515	17,299	8,983	8,598	9,131	19,484	20,113	26,429
19.0-20.9	6,180	8,266	11,087	5,896	6,133	6,341	12,077	14,399	17,427
21.0-22.9	4,194	4,886	7,234	4,493	4,174	6,187	8,687	9,060	13,421
23.0-24.9	2,988	3,282	5,015	2,866	2,545	3,215	5,854	5,827	8,230
25.0-26.9	1,522	1,873	2,453	1,430	2,212	1,928	2,952	4,086	4,380
27.0-28.9	1,087	786	1,562	1,464	1,224	1,895	2,550	2,011	3,457
29.0-30.9	386	1,073	1,416	813	1,538	556	1,199	2,611	1,972
31.0-32.9	0	274	258	637	1,128	1,460	637	1,402	1,718
33.0-34.9	170	175	326	0	345	222	170	519	548
35.0-36.9	0	0	261	405	0	450	405	0	711
37.0-38.9	0	0	0	0	0	447	0	0	447
39.0-40.9	0	0	0	0	0	0	0	0	0
41.0+	0	0	0	465	647	0	465	647	0
Total	**215,135**	**244,139**	**282,879**	**112,898**	**102,004**	**108,452**	**328,034**	**346,143**	**391,331**

Source: USDA - US Forest Service

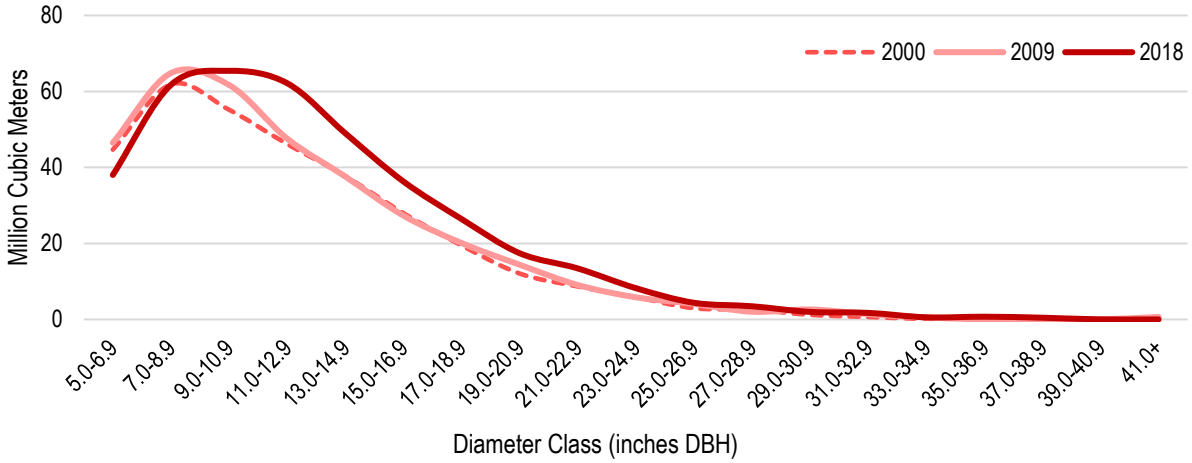
***Figure 35**. Georgia Catchment Area - Timber Inventory by Major Species Group & Diameter Class (2000, 2009, & 2018)*



(a) Softwood Growing Stock Inventory



(b) Hardwood Growing Stock Inventory



(c) Total Growing Stock Inventory

6.1.4.2 *Age Class Distribution*

Changes in growing stock inventory by age class aligns with changes in diameter class distribution. Specifically, USFS data indicates that the average age of softwood growing stock inventory increased from 36.9 years old in 2000 to 39.1 years old in 2018. The average age of hardwood growing stock inventory also increased over this same period – from 55.7 years old in 2000 to 60.6 years old in 2018.

The increase in the average age of both softwood and hardwood growing stock inventory is reflected in changes in age class distributions over this period. Specifically, the distribution of softwood growing stock inventory 50 years of age or younger decreased from 75% in 2000 to 73% in 2009 and to 71% in 2018. Similarly, the distribution of hardwood growing stock inventory 65 years of age or younger decreased from 68% to 66% and to 55% over these same three periods.

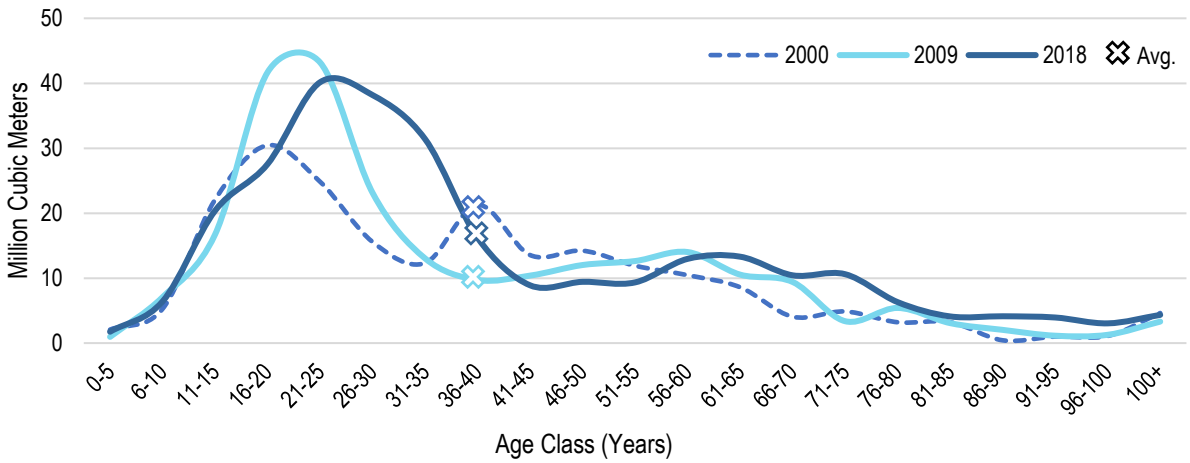
Table 29 below provides US Forest Service estimates of softwood and hardwood growing stock inventory by age class in 2000, 2009, and 2018. Corresponding values are shows graphically in Figure 36 on the following page.

***Table 29**. Georgia Catchment Area - Timber Inventory by Major Species Group & Age Class (2000, 2009, & 2018)*

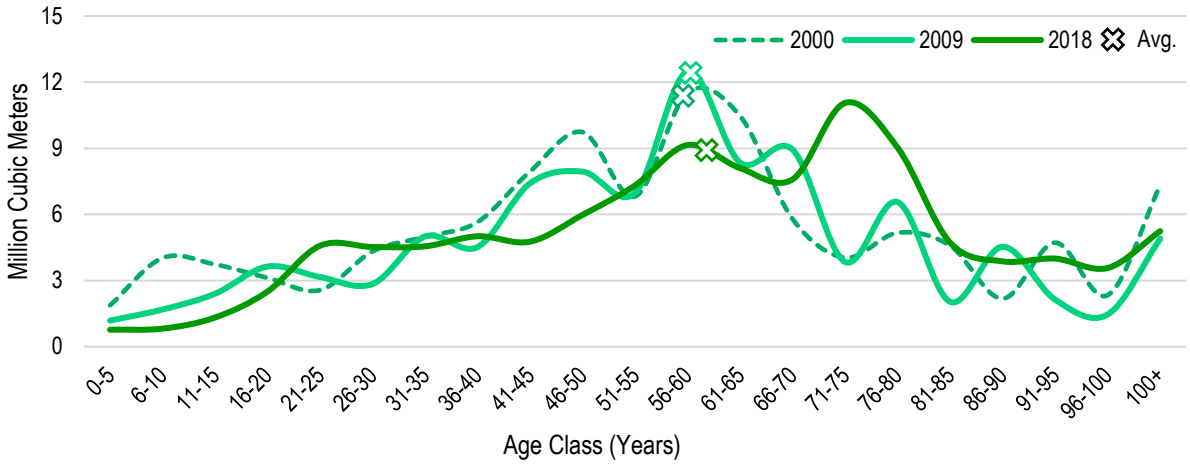
Age Class	Softwood			Hardwood			Total		
(years)	2000	2009	2018	2000	2009	2018	2000	2009	2018
				(000 Cubic Meters)					
0-5	2,076	958	1,753	1,875	1,183	771	3,951	2,140	2,524
6-10	5,266	7,069	6,408	4,025	1,687	819	9,291	8,755	7,227
11-15	22,079	16,714	20,375	3,733	2,400	1,323	25,812	19,114	21,698
16-20	30,441	41,686	27,552	3,120	3,636	2,501	33,561	45,322	30,054
21-25	24,840	43,205	40,150	2,569	3,160	4,581	27,409	46,365	44,731
26-30	15,575	23,125	38,179	4,323	2,846	4,523	19,898	25,970	42,701
31-35	12,327	13,036	31,405	4,987	5,001	4,552	17,314	18,037	35,957
36-40	21,279	9,721	16,207	5,655	4,520	5,009	26,934	14,241	21,216
41-45	13,554	10,392	8,895	7,949	7,415	4,763	21,503	17,806	13,658
46-50	14,226	12,020	9,432	9,733	7,940	5,980	23,960	19,960	15,412
51-55	11,909	12,633	9,346	6,815	6,977	7,315	18,724	19,610	16,661
56-60	10,458	14,018	12,968	11,522	12,489	9,147	21,980	26,507	22,115
61-65	8,594	10,539	13,303	10,461	8,350	8,097	19,055	18,889	21,400
66-70	4,060	9,410	10,434	5,785	8,935	7,594	9,845	18,344	18,028
71-75	4,867	3,369	10,605	4,041	3,842	11,059	8,908	7,212	21,664
76-80	3,208	5,410	6,305	5,169	6,560	9,024	8,376	11,970	15,329
81-85	3,215	3,075	4,107	4,582	2,035	4,717	7,797	5,110	8,824
86-90	427	2,037	4,130	2,179	4,533	3,870	2,606	6,570	8,001
91-95	1,003	1,140	3,941	4,717	2,133	3,996	5,720	3,273	7,937
96-100	1,101	1,275	3,039	2,337	1,463	3,570	3,438	2,738	6,609
100+	4,629	3,309	4,343	7,322	4,898	5,241	11,951	8,207	9,584
Total	**215,135**	**244,139**	**282,879**	**112,898**	**102,004**	**108,452**	**328,034**	**346,143**	**391,331**

Source: USDA - US Forest Service

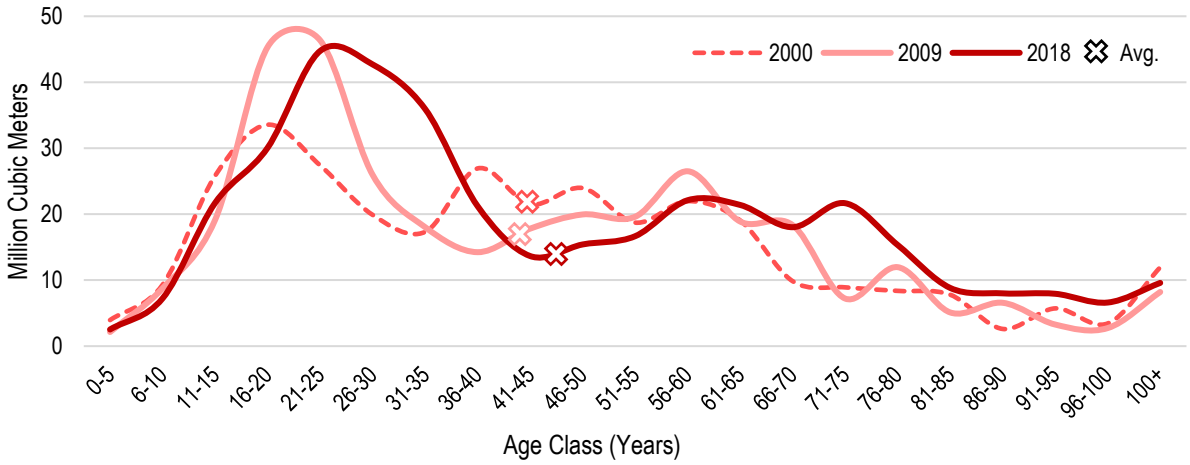
***Figure 36**. Georgia Catchment Area - Timber Inventory by Major Species Group & Age Class (2000, 2009, & 2018)*



(a) Softwood Growing Stock Inventory



(b) Hardwood Growing Stock Inventory



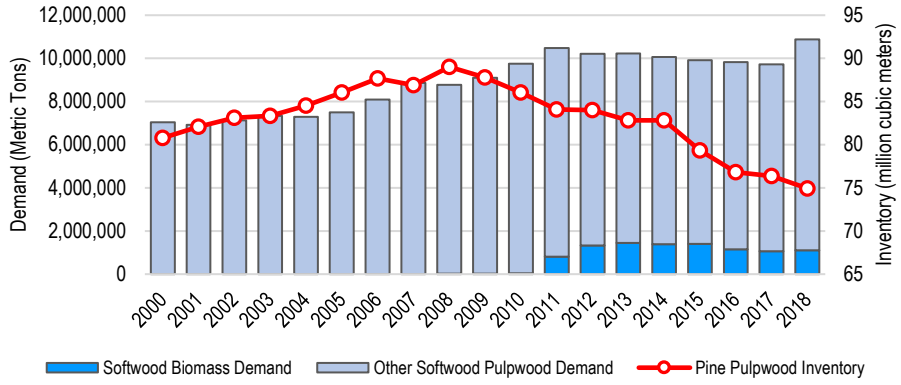
(c) Total Growing Stock Inventory

Correlation Analysis: *Biomass Demand vs. Timber Inventory*

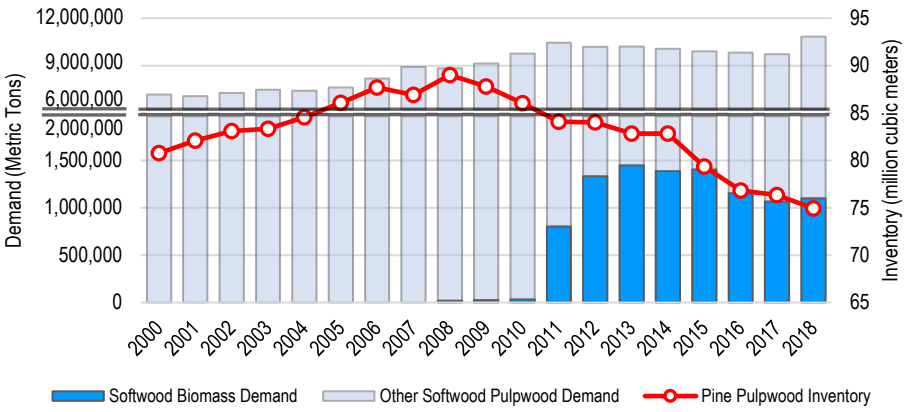
US Forest Service data shows that total timber inventory has steadily increased an average of 1.0% per year in the Georgia catchment area since 2000. Intuitively, timber inventories can increase one of two ways: 1) through additional timberland gains or 2) through an environment in which annual growth outpaces annual removals. In this catchment area, the latter has occurred. Specifically, annual timber growth has continued to outpace total annual removals (demand), leading to oversupply and increased inventory levels.

However, we would like to note that inventories of pine pulpwood – the predominant timber product utilized by the bioenergy industry – have steadily declined since 2008, while total pulpwood demand has increased (see Figure 37). Although correlation analysis identified no meaningful relationship between pine pulpwood inventory and pine pulpwood demand from 2000-2018 (correlation coefficient=-0.32), a moderately strong negative relationship (correlation coefficient=-0.59) was found between these two variables from 2008-2018. Results were similar (correlation coefficient=-0.66) for pine pulpwood inventory and softwood biomass demand over this same period.

***Figure 37**. Georgia Catchment Area – Biomass Demand & Total Pulpwood Demand vs. Pulpwood Inventory (2000-2018)*



(a) Softwood Pulpwood Demand vs. Pine Pulpwood Inventory



(b) Softwood Biomass Demand vs. Pine Pulpwood Inventory

The negative correlations found between pine pulpwood inventory and both softwood biomass demand and non-biomass-related softwood pulpwood demand since 2008 suggest that increases in total pulpwood demand (from both bioenergy and other sources), to some degree, has resulted in decreased inventories of pine pulpwood. However, changes in softwood inventory by diameter class indicate the decrease in pine pulpwood inventory is more closely linked to changes in diameter class distribution. Specifically, this data indicates that the catchment area forest is in a state of transition, with pine pulpwood inventory moving up in product class and ultimately resulting in reduced pine pulpwood inventory levels.

***Table 30**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Timber Inventory (2000-2018)*

	Softwood Biomass Demand	*Other Softwood Pulpwood Demand*	*Total Softwood Pulpwood Demand*	*Pine Pulpwood Inventory*	*Total Pine Inventory*
Softwood Biomass Demand	1				
Other Softwood Pulpwood Demand	0.48	1			
Total Softwood Pulpwood Demand	0.80	0.91	1		
Pine Pulpwood Inventory	-0.60	-0.06	-0.32	1	
Total Pine Inventory	0.84	0.76	0.91	-0.52	1

	Hardwood Biomass Demand	*Other Hardwood Pulpwood Demand*	*Total Hardwood Pulpwood Demand*	*Hardwood Pulpwood Inventory*	*Total Hardwood Inventory*
Hardwood Biomass Demand	1				
Other Hardwood Pulpwood Demand	-0.48	1			
Total Hardwood Pulpwood Demand	-0.36	0.99	1		
Hardwood Pulpwood Inventory	-0.41	0.90	0.90	1	
Total Hardwood Inventory	-0.11	0.75	0.78	0.93	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Inventory*	*Total Inventory*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.56	1			
Total Biomass Demand	0.99	0.61	1		
Total Pulpwood Inventory	-0.80	-0.89	-0.83	1	
Total Inventory	0.81	0.79	0.83	-0.81	1

6.1.5 *Changes in Annual Timber Growth*

Timber growth data for the Georgia catchment area was provided by the US Forest Service - Forest Inventory & Analysis (FIA) program. However, note that FIA growth data for this catchment area is only available since 2004.

According to US Forest Service data, net annual growth of growing stock timber steadily increased at an average rate of 0.5% per year from 20.9 million m^3 in 2004 to 22.1 million m^3 in 2016. However, since 2016, annual growth has increased at a more accelerated rate, increasing an average of 3.2% per year to 23.6 million m^3 in 2018. Overall, total annual growth increased 13% from 2004-2018.

Table 31 below (as well as Figure 38 on the following page) provides a breakdown of annual timber growth by major timber product from 2004 through 2018, the latest available. Note that annual growth of pine sawtimber and pine chip-n-saw both held relatively steady from 2004-2010 before increasing 78% and 22%, respectively, from 2010-2018. Annual growth of pine pulpwood also held steady from 2004-2010, averaging 10.7 million m^3 per year over this period. However, pine pulpwood growth proceeded to decline 14% over the eight years that followed, falling to 9.2 million m^3 in 2018.

***Table 31**. Georgia Catchment Area - Annual Growth by Major Timber Product (2004-2018)*

	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(000 Cubic Meters)			
2004	2,999	3,975	10,512	1,429	1,943	20,858
2005	2,923	4,275	10,593	1,132	1,670	20,592
2006	2,958	4,425	10,766	1,154	1,779	21,083
2007	2,802	4,527	10,788	1,111	1,859	21,087
2008	2,879	4,547	10,902	1,072	1,902	21,303
2009	2,886	4,490	10,856	974	1,873	21,078
2010	3,052	4,577	10,703	941	1,974	21,247
2011	3,268	4,591	10,587	892	1,969	21,307
2012	3,536	4,646	10,571	860	1,901	21,514
2013	3,795	4,763	10,493	790	1,803	21,645
2014	4,107	4,991	10,471	812	1,795	22,176
2015	4,391	5,031	10,018	736	1,720	21,896
2016	4,595	5,135	9,806	765	1,804	22,106
2017	5,007	5,503	9,520	986	1,982	22,998
2018	5,438	5,598	9,193	1,182	2,152	23,563

Source: USDA-US Forest Service

Figure 38. Georgia Catchment Area - Net Annual Growth of Growing Stock Timber on Timberland (2004-2018)

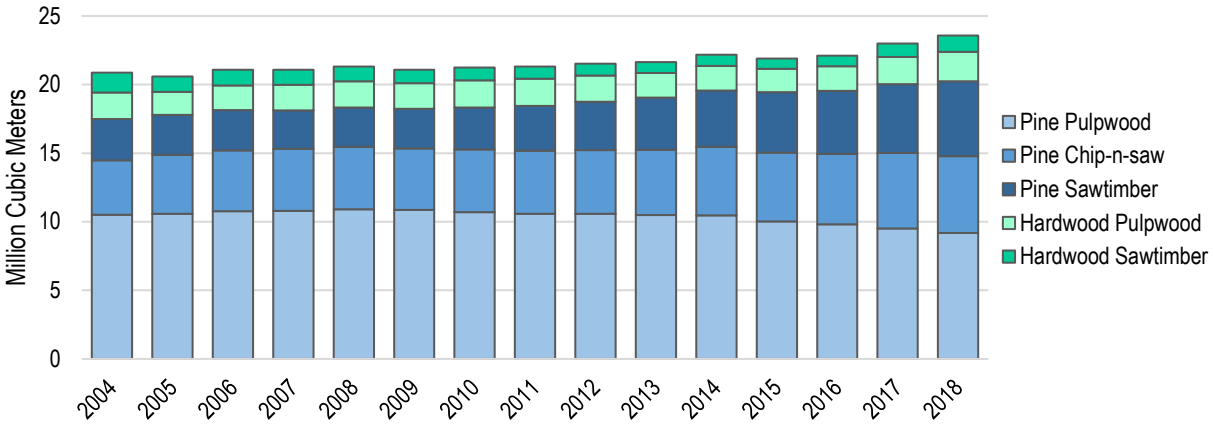
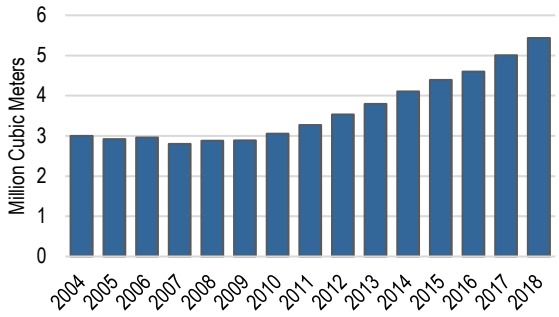
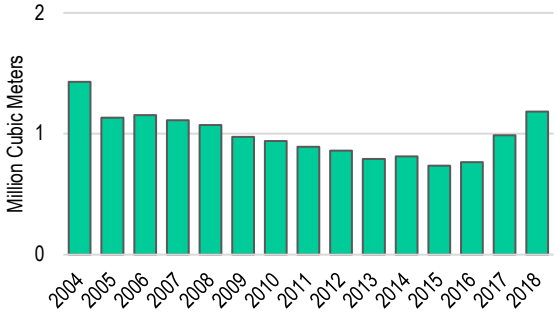


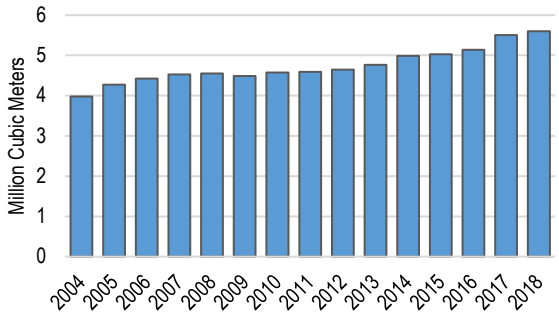
Figure 39. Georgia Catchment Area - Net Annual Growth by Major Timber Product (2004-2018)



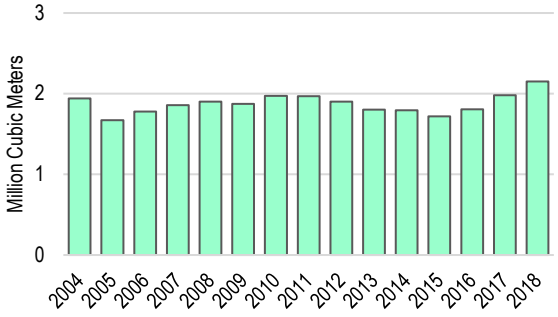
(a) Pine Sawtimber



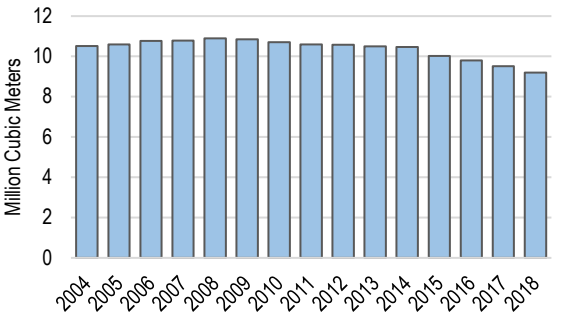
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

6.1.5.1 *Growth Rates & Per-Hectare Growth*

According to USFS data, average annual growth rates in the catchment area remained nearly unchanged from 2004-2018, holding between 6.0% and 6.3% per year over this period. Specifically, average annual growth rates of pine pulpwood, the primary timber product consumed by the bioenergy sector, held between 12.2% and 12.8% per year from 2004-2018. See Table 32 below for details.

Furthermore, average per-hectare volume growth in the Georgia catchment area increased from 5.1 m^3 in 2004 to 5.9 m^3 in 2018, with average per-hectare growth increasing for both pine sawtimber and pine chip-n-saw but decreasing slightly for pine pulpwood over this period (see Table 33). Ultimately, this information taken together is suggestive of two things: 1) the catchment area forest has become more productive and 2) the forest is in a state of transition where timber is moving up in product class (i.e. pulpwood is moving up to chip-n-saw and chip-n-saw is moving up to sawtimber).

In general, growth rates decline as timber ages. So, the decrease in pine pulpwood growth rate and simultaneous increase in pine chip-n-saw growth rate suggests that pine pulpwood is moving up in classification to pine chip-n-saw. Pine pulpwood growth declines as it moves closer to chip-n-saw classification, and just the opposite occurs with pine chip-n-saw, as its growth rate increases due to the influx of younger timber into this new classification.

***Table 32**. Georgia Catchment Area - Average Annual Growth Rate by Major Timber Product (2004-2018)*

	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			Annual Growth Rate (%)			
2004	3.5%	7.0%	12.4%	2.5%	4.2%	6.3%
2005	3.3%	7.1%	12.3%	2.0%	3.7%	6.1%
2006	3.3%	7.2%	12.3%	1.9%	3.8%	6.1%
2007	3.2%	7.3%	12.4%	1.9%	4.1%	6.2%
2008	3.2%	7.2%	12.2%	1.8%	4.2%	6.1%
2009	3.1%	7.0%	12.4%	1.7%	4.2%	6.1%
2010	3.2%	7.0%	12.4%	1.6%	4.3%	6.0%
2011	3.3%	6.9%	12.6%	1.6%	4.3%	6.1%
2012	3.5%	6.7%	12.6%	1.5%	4.2%	6.0%
2013	3.5%	6.7%	12.7%	1.4%	4.1%	6.0%
2014	3.7%	6.9%	12.6%	1.5%	4.1%	6.1%
2015	3.8%	6.9%	12.6%	1.3%	4.1%	6.0%
2016	3.9%	7.1%	12.8%	1.3%	4.2%	6.0%
2017	4.0%	7.4%	12.5%	1.6%	4.5%	6.1%
2018	4.1%	7.4%	12.3%	1.9%	4.7%	6.0%

Source: USDA - US Forest Service

***Table 33**. Georgia Catchment Area - Average Per Hectare Volume Growth by Major Timber Product (2004-2018)*

Year	Softwood			Hardwood		Total
	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	
	(Cubic Meters/Hectare/Year)					
2004	0.73	0.97	2.57	0.35	0.47	5.09
2005	0.71	1.05	2.59	0.28	0.41	5.03
2006	0.72	1.08	2.62	0.28	0.43	5.14
2007	0.68	1.10	2.62	0.27	0.45	5.13
2008	0.70	1.11	2.65	0.26	0.46	5.18
2009	0.70	1.09	2.64	0.24	0.46	5.13
2010	0.74	1.11	2.60	0.23	0.48	5.17
2011	0.79	1.12	2.58	0.22	0.48	5.18
2012	0.86	1.13	2.58	0.21	0.46	5.24
2013	0.93	1.17	2.57	0.19	0.44	5.30
2014	1.01	1.23	2.57	0.20	0.44	5.45
2015	1.09	1.24	2.48	0.18	0.42	5.41
2016	1.14	1.27	2.43	0.19	0.45	5.48
2017	1.25	1.37	2.37	0.25	0.49	5.74
2018	1.36	1.40	2.30	0.30	0.54	5.90

Source: USDA - US Forest Service

***Figure 40**. Georgia Catchment Area – Average Timber Growth Rate & Total Per-Hectare Volume Growth (2004-2018)*

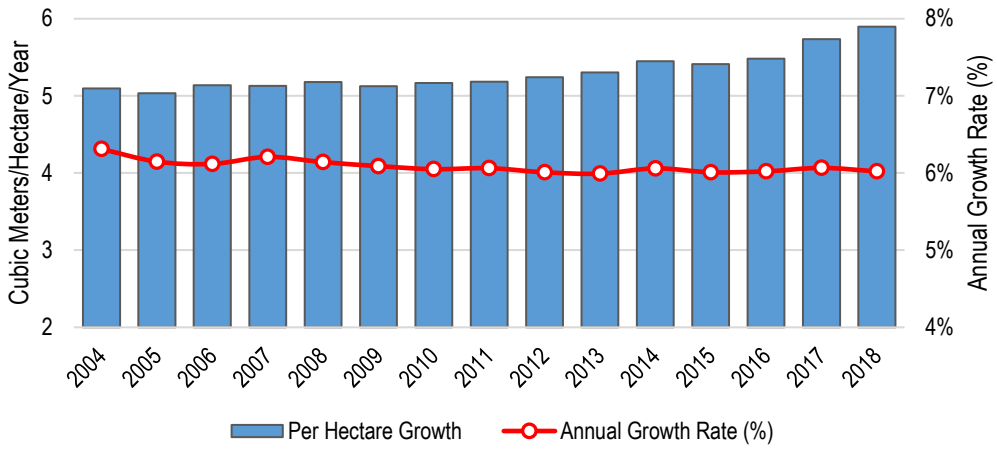
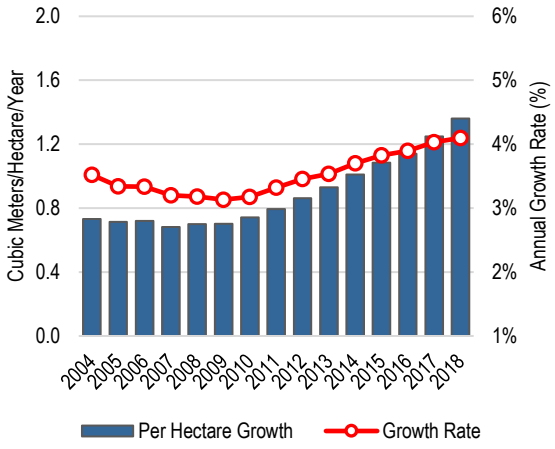
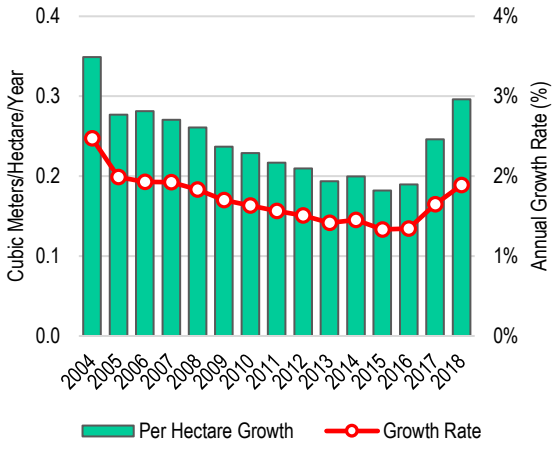


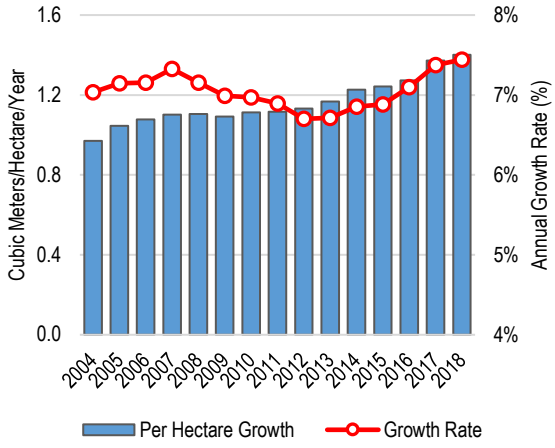
***Figure 41**. Georgia Catchment Area - Annual Growth Rates & Per-Acre Growth by Major Timber Product (2004-2018)*



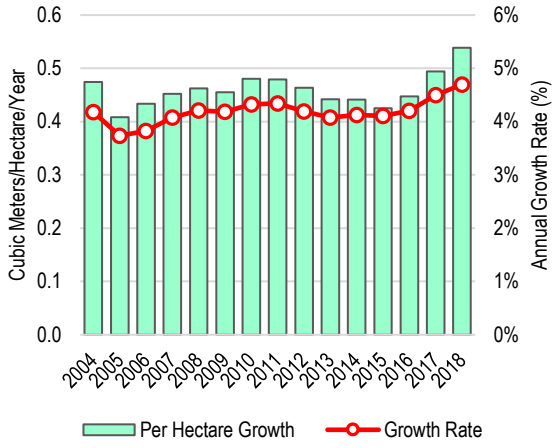
(a) Pine Sawtimber



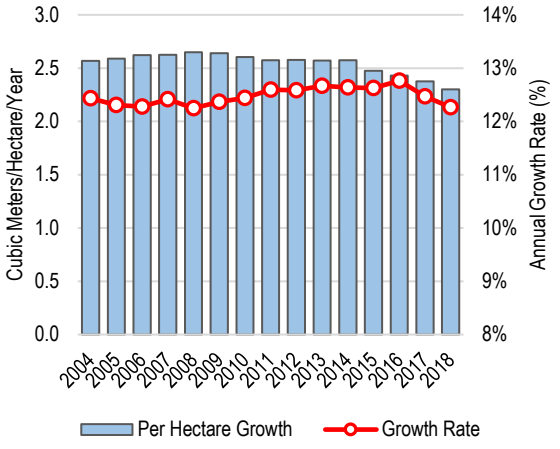
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

Growth Rates, Age Class, & Diameter Class

As was noted on page 76, the decrease in pine pulpwood growth rate and subsequent increase in pine chip-n-saw growth rate since 2012 suggests that softwood forests in the catchment area are transitioning, with a significant portion of softwood inventory moving up in product class (from pine pulpwood to pine chip-n-saw). To demonstrate and help further explain this transition – including how this impacts growth rates – let's look at a typical yield curve for a pine timber stand as well as the growth rate curve.

Figure 42, below, shows softwood growing stock inventory in the catchment area by age class in 2018, including an overlay of the yield curve for a typical pine timber stand. Looking at this figure, notice that the majority of softwood growing stock inventory is located along the yield curve in those age classes where gross volume increases at a rapid pace. Specifically, according to USFS data, 56% of softwood inventory is 11-35 years of age, or within those age classes where pine pulpwood transitions to pine chip-n-saw and pine chip-n-saw transitions to pine sawtimber.

Going a bit further, Figure 43 on the following page shows softwood growing stock inventory in the catchment area by diameter class, including the corresponding growth rate associated with each respective diameter class. Also note that specific product classifications have been identified and are highlighted in this figure. What we want to draw your attention to is where the highest distributions are located within each highlighted product class. Specifically, a majority of pine pulpwood inventory (highlighted in green) is at the top end of its diameter class range (and the bottom end of its growth rate rage), whereas a majority of pine chip-n-saw inventory (highlighted in yellow) is at the bottom end of its diameter class range (and the top end of its growth rate range).

***Figure 42**. Distribution of Softwood Growing Stock Inventory by Age Class vs. Typical Pine Gross Yield Curve*

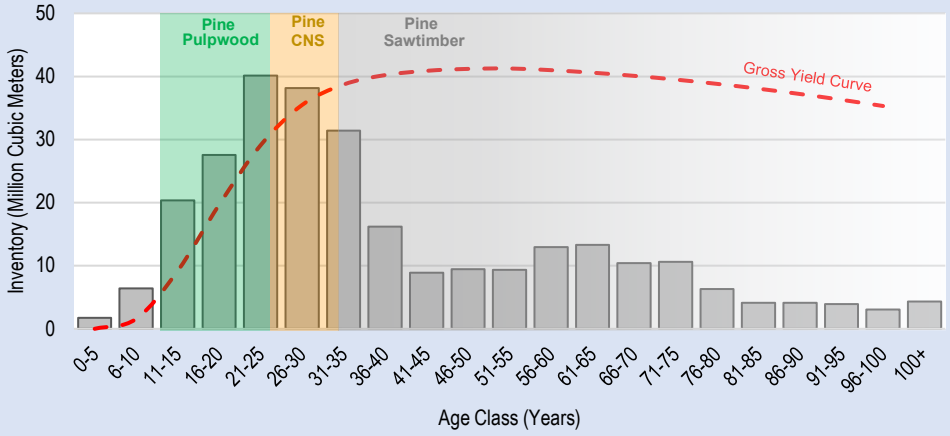
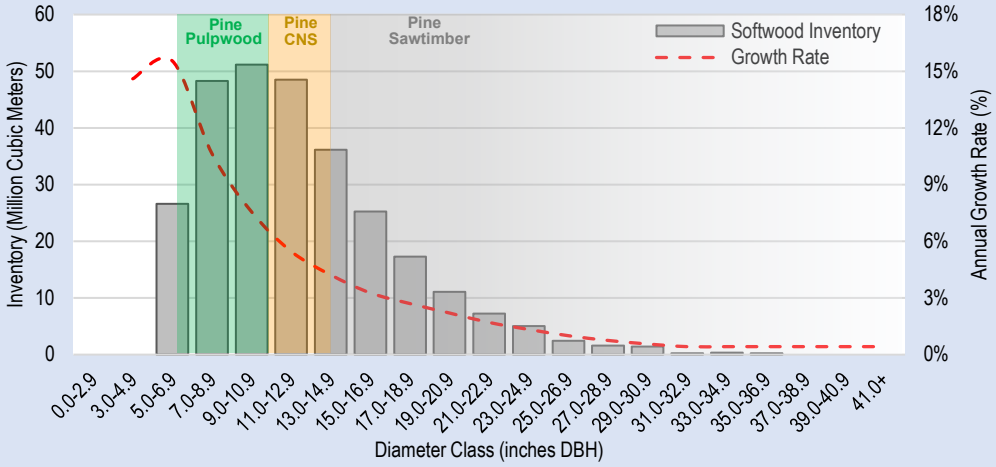


***Figure 43**. Distribution of Softwood Growing Stock Inventory by Diameter Class vs. Softwood Growth Rate Curve*



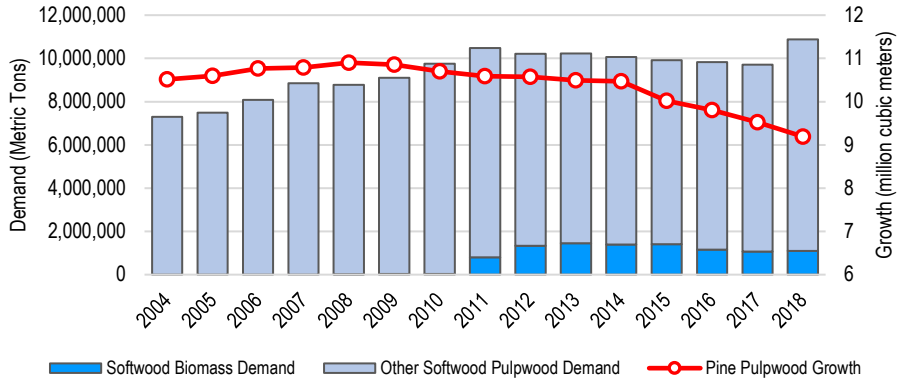
Ultimately, the decline in pine pulpwood growth rate and increase in pine chip-n-saw growth rate since 2012 (as shown in Table 32 on pg. 76) indicate that the catchment area forest has been in a state of transition. And as these figures show/illustrate, this transition – and the change in growth rates – can be explained and better understood if we consider the natural growth cycle of timber and how this cycle impacts timber growth rates.

Correlation Analysis: *Biomass Demand vs. Timber Growth*

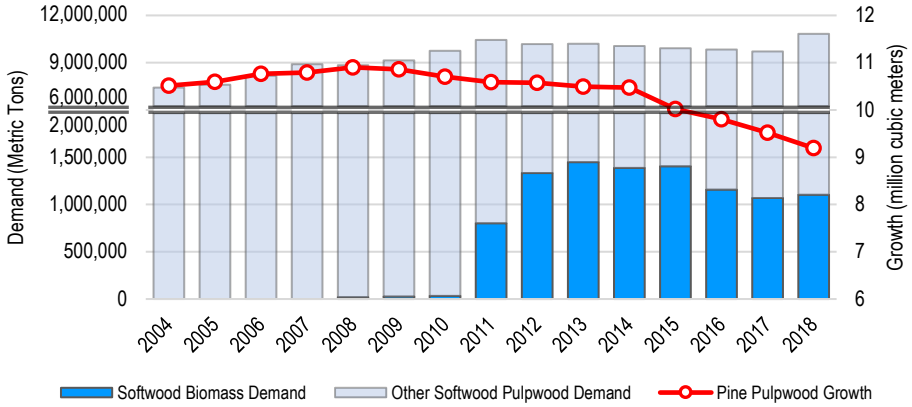
Figure 44 provides a side-by-side comparison of softwood pulpwood demand (including softwood biomass demand) and annual pine pulpwood growth in the catchment area from 2004-2018. This figure shows that, since 2004, total softwood pulpwood demand in the catchment area has increased while pine pulpwood growth has declined. However, since 2011, pine pulpwood growth has declined at a more rapid pace, despite softwood pulpwood demand remaining nearly unchanged (actually decreasing from 2011-2017). Ultimately, statistical analysis identified a weak negative correlation (correlation coefficient=-0.47) between these two variables from 2004-2018. Findings were also similar in comparing softwood biomass demand and pine pulpwood growth over this same period (correlation coefficient=-0.59).

Intuitively, an inverse relationship is generally expected between demand and growth. However, we see that softwood pulpwood demand and pine pulpwood growth moved in the same direction from 2011-2017, even though softwood biomass demand increased over this period. Ultimately, there is little evidence that softwood biomass demand was responsible for this decrease in pine pulpwood growth. Rather, evidence points towards reduced sawtimber harvest levels through the second half of the 2000s, which translated to less new stand reestablishment, reduced pine pulpwood inventory levels, and ultimately a reduction in pine pulpwood growth.

***Figure 44**. Georgia Catchment Area – Softwood Pulpwood Demand vs. Annual Pine Pulpwood Growth (2004-2018)*



(a) Softwood Pulpwood Demand vs. Pine Pulpwood Growth



(b) Softwood Biomass Demand vs. Pine Pulpwood Growth

***Table 34**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Annual Timber Growth (2004-2018)*

	Softwood Biomass Demand	*Other Softwood Pulpwood Demand*	*Total Softwood Pulpwood Demand*	*Pine Pulpwood Growth*	*Total Pine Growth*
Softwood Biomass Demand	1				
Other Softwood Pulpwood Demand	0.27	1			
Total Softwood Pulpwood Demand	0.77	0.82	1		
Pine Pulpwood Growth	-0.59	-0.19	-0.47	1	
Total Pine Growth	0.81	0.44	0.77	-0.83	1

	Hardwood Biomass Demand	*Other Hardwood Pulpwood Demand*	*Total Hardwood Pulpwood Demand*	*Hardwood Pulpwood Growth*	*Total Hardwood Growth*
Hardwood Biomass Demand	1				
Other Hardwood Pulpwood Demand	-0.61	1			
Total Hardwood Pulpwood Demand	-0.34	0.95	1		
Hardwood Pulpwood Growth	0.36	-0.19	-0.09	1	
Total Hardwood Growth	0.08	0.45	0.56	0.71	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Growth*	*Total Growth*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.51	1			
Total Biomass Demand	0.99	0.57	1		
Total Pulpwood Growth	-0.63	-0.94	-0.68	1	
Total Growth	0.67	0.88	0.71	-0.83	1

6.1.6 *Changes in Annual Removals*

According to the US Forest Service, annual removals of growing stock timber held relatively consistent in the catchment area, averaging 17.8 million m^3 per year from 2000-2017. However, in 2018, total removals increased to an estimated 21.1 million m^3, up 16% from 2017 levels.

Table 35 below provides a breakdown of annual removal estimates by major timber product in the Georgia catchment area from 2000 through 2018. Annual removals of pine sawtimber and pine chip-n-saw (i.e. softwood sawlogs) steadily declined from a combined 9.3 million m^3 in 2000 to 8.2 million m^3 in 2014. However, removals of softwood sawlogs have steadily increased since and in 2018 totaled 11.0 million m^3, which was up 35% compared to 2014 levels.

Annual removals of pine pulpwood (the primary roundwood product consumed by the bioenergy sector) increased 41% from 5.2 million m^3 in 2000 to 7.6 million m^3 in 2011 but then proceeded to decline an average of 2.3% per year (-13% total) to 6.6 million m^3 in 2017. However, pine pulpwood removals increased to 8.7 million m^3 in 2018, a year-over-year increase of 31%. (Note that the increase in pine pulpwood removals in 2018 was due to Hurricane Michael, a category 5 hurricane that hit the Florida Panhandle, causing damage to an estimated 2.1 million hectares of timberland, including 100 million metric tons of timber, in Florida and Georgia).

***Table 35**. Georgia Catchment Area - Annual Removals by Major Timber Product (2000-2018)*

	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(000 Cubic Meters)			
2000	4,836	4,473	5,214	1,472	1,999	17,996
2001	4,786	4,435	5,114	1,521	1,966	17,821
2002	4,693	4,362	5,246	1,563	1,857	17,720
2003	4,601	4,287	5,378	1,603	1,734	17,603
2004	4,678	4,423	5,377	1,600	1,670	17,747
2005	4,671	4,566	5,824	1,574	1,645	18,280
2006	4,404	4,507	5,918	1,494	1,401	17,725
2007	4,181	4,756	6,252	1,737	1,418	18,344
2008	3,958	4,494	6,107	1,477	1,152	17,187
2009	4,044	4,694	6,577	1,532	1,145	17,992
2010	3,820	5,072	6,998	1,224	918	18,031
2011	3,931	5,269	7,605	1,105	970	18,879
2012	3,668	4,747	7,332	712	740	17,200
2013	3,574	4,748	7,453	700	892	17,367
2014	3,562	4,616	7,235	518	861	16,791
2015	4,163	4,667	6,984	671	979	17,464
2016	4,638	4,981	6,803	573	841	17,836
2017	4,860	5,262	6,596	599	949	18,266
2018	5,336	5,692	8,654	622	827	21,131

Source: USDA - US Forest Service

***Figure 45**. Georgia Catchment Area - Annual Removals by Year (2000-2018)*

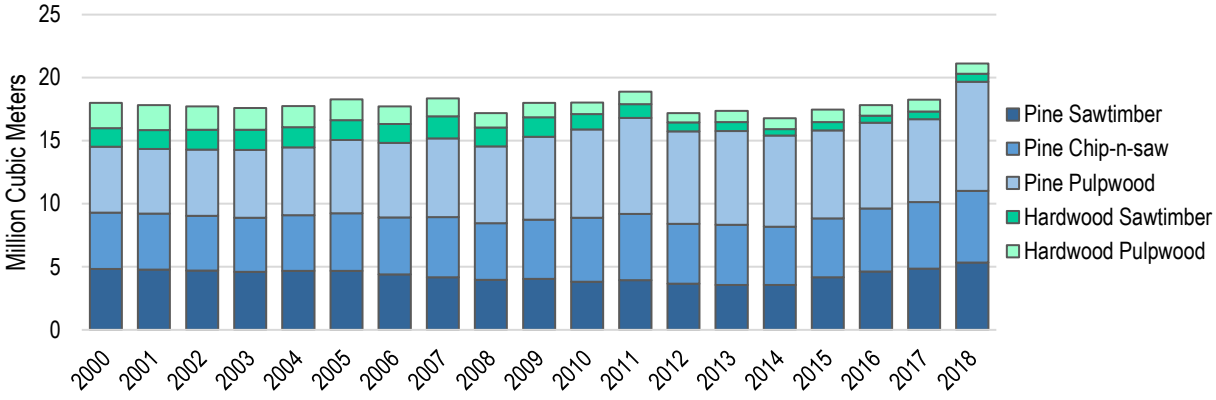
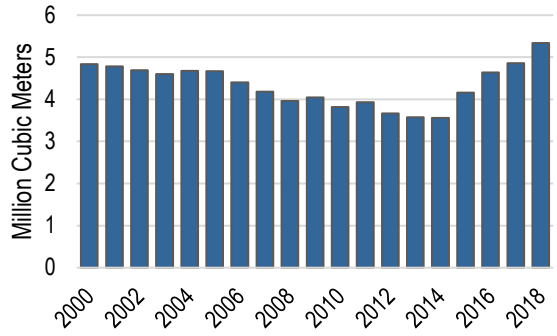
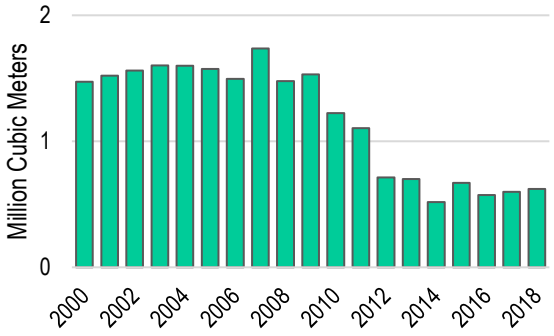


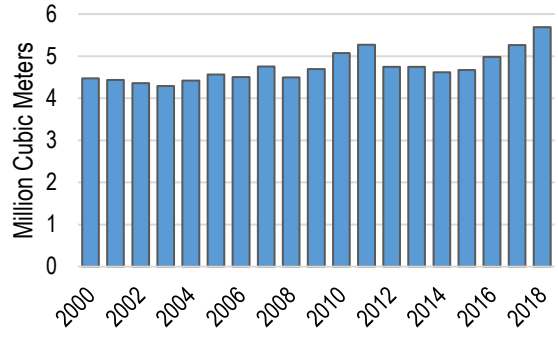
***Figure 46**. Georgia Catchment Area - Annual Removals by Major Timber Product (2000-2018)*



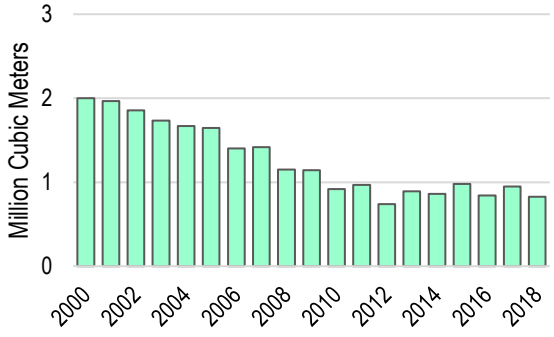
(a) Pine Sawtimber



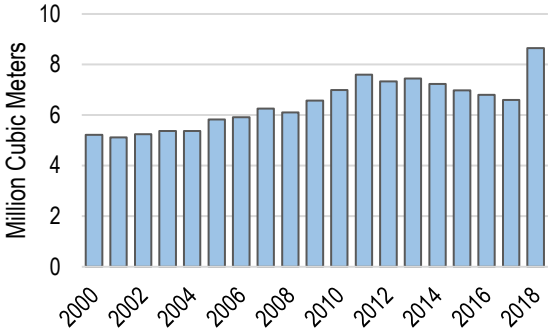
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

6.1.6.1 *Growth-to-Removals Ratios*

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

According to US Forest Service data, the growth-to-removals (G:R) ratio for pine pulpwood, the primary bioenergy feedstock, remained well above 1.0 in the catchment area from 2004-2017, indicating that harvest levels remained well below the sustainable yield capacity of the forest area over this period. Specifically, the pine pulpwood G:R ratio equaled nearly 2.0 in 2004, steadily declining over the seven years that followed but leveling out and averaging 1.43 from 2011-2017. However, as a result of the removals/salvage wood brought about by Hurricane Michael, the pine pulpwood G:R ratio fell to 1.06 in 2018.

Unsustainable harvest levels persisted in the catchment area for both pine (and hardwood) sawtimber through the 2000s. However, reduced harvest levels in the late 2000s through early 2010s (due to market conditions brough about by the Great Recession) allowed inventories to replenish, and since 2013, pine sawtimber markets have remained balanced – with harvest levels roughly equal to (slightly below) the sustainable yield capacity of the forest area.

***Table 36**. Georgia Catchment Area – Growth-to-Removals Ratios (2004-2018)*

	Softwood			Hardwood		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(Growth-to-Removals Ratio)			
2004	0.64	0.90	1.96	0.89	1.16	1.18
2005	0.63	0.94	1.82	0.72	1.02	1.13
2006	0.67	0.98	1.82	0.77	1.27	1.19
2007	0.67	0.95	1.73	0.64	1.31	1.15
2008	0.73	1.01	1.79	0.73	1.65	1.24
2009	0.71	0.96	1.65	0.64	1.64	1.17
2010	0.80	0.90	1.53	0.77	2.15	1.18
2011	0.83	0.87	1.39	0.81	2.03	1.13
2012	0.96	0.98	1.44	1.21	2.57	1.25
2013	1.06	1.00	1.41	1.13	2.02	1.25
2014	1.15	1.08	1.45	1.57	2.08	1.32
2015	1.05	1.08	1.43	1.10	1.76	1.25
2016	0.99	1.03	1.44	1.33	2.15	1.24
2017	1.03	1.05	1.44	1.65	2.09	1.26
2018	1.02	0.98	1.06	1.90	2.60	1.12

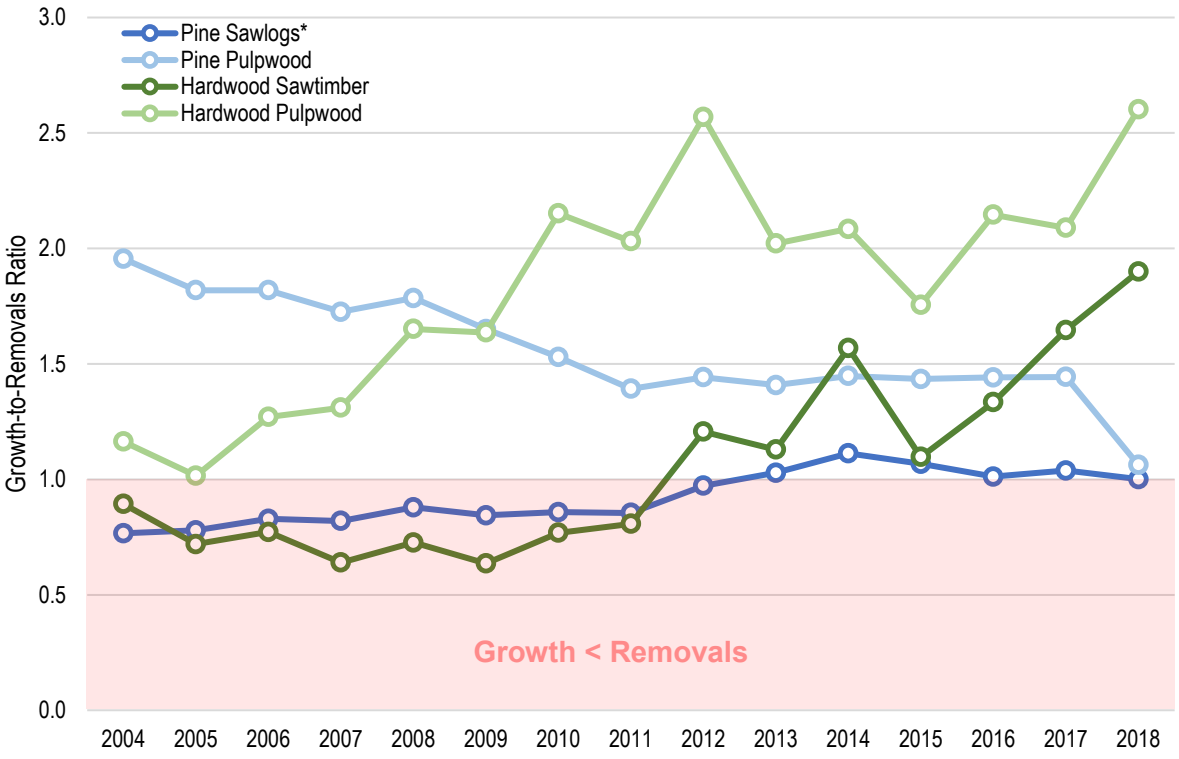
Source: USDA - US Forest Service

Figure 47, below, shows growth-to-removals ratios in the catchment area for the major timber products from 2004-2018. As this figure shows (and was noted on the previous page), the pine pulpwood G:R ratio steadily declined from 2004-2011. Note that this decline was linked to a combination of reduced pine pulpwood growth and increased pine pulpwood removals.

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

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

***Figure 47**. Georgia Catchment Area – Growth-to-Removals Ratios by Major Timber Product (2004-2018)*



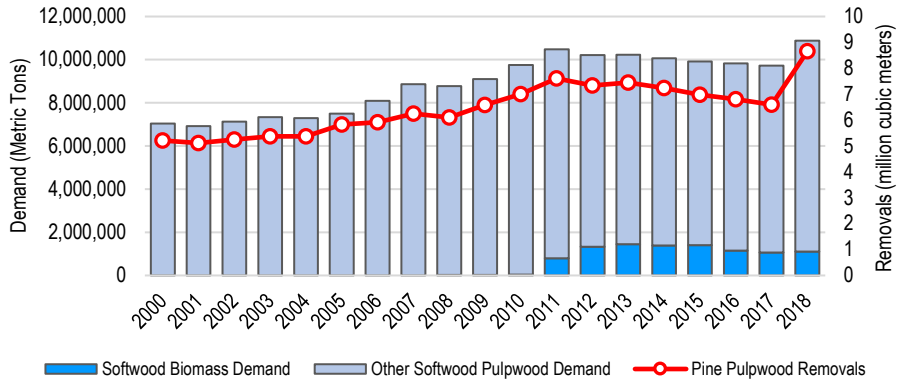
*Pine sawlogs includes pine sawtimber and pine chip-n-saw

Correlation Analysis: *Biomass Demand vs. Timber Removals*

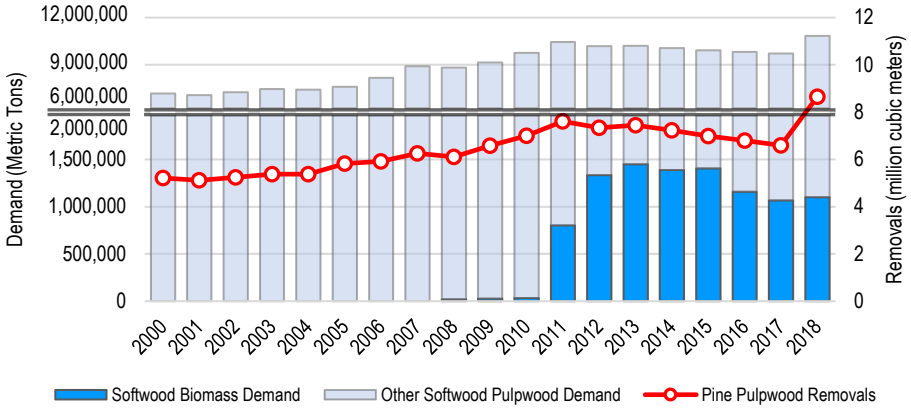
Figure 48 provides a side-by-side comparison of biomass demand and total pulpwood demand versus pulpwood removals in the catchment area from 2000-2018. Since pulpwood removals, in general, should be representative of pulpwood demand, we'd expected these two to be very strongly (positively) correlated, and that's exactly what we see in Figure 48. Statistical analysis confirms this relationship, identifying a strong positive correlation between softwood pulpwood demand and pine pulpwood removals (correlation coefficient=0.94) as well as between hardwood pulpwood demand and hardwood pulpwood removals (correlation coefficient=0.96) in the catchment area over this period.

Looking specifically at Figure 48(b), we also see that softwood biomass demand appears to loosely track pine pulpwood removals, particularly since around 2012. However, only a weak positive relationship was found between these two variables from 2008-2018 (correlation coefficient=0.47). Ultimately, softwood biomass demand, which accounts for only 10-15% of total softwood pulpwood demand, has had an impact on the total level of pine pulpwood removals in the Georgia catchment area. However, demand from other sources (i.e. pulp/paper) is the primary driver of pine pulpwood removals in the Georgia catchment area.

***Figure 48**. Georgia Catchment Area – Softwood Pulpwood Demand vs. Annual Pine Pulpwood Removals (2000-2018)*



(a) Softwood Pulpwood Demand vs. Pine Pulpwood Removals



(b) Softwood Biomass Demand vs. Pine Pulpwood Removals

***Table 37**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Annual Timber Removals (2000-2018)*

	Softwood Biomass Demand	*Other Softwood Pulpwood Demand*	*Total Softwood Pulpwood Demand*	*Pine Pulpwood Removals*	*Total Pine Removals*
Softwood Biomass Demand	1				
Other Softwood Pulpwood Demand	0.47	1			
Total Softwood Pulpwood Demand	0.80	0.91	1		
Pine Pulpwood Removals	0.75	0.88	0.96	1	
Total Pine Removals	0.31	0.22	0.30	0.41	1

	Hardwood Biomass Demand	*Other Hardwood Pulpwood Demand*	*Total Hardwood Pulpwood Demand*	*Hardwood Pulpwood Removals*	*Total Hardwood Removals*
Hardwood Biomass Demand	1				
Other Hardwood Pulpwood Demand	-0.49	1			
Total Hardwood Pulpwood Demand	-0.37	0.99	1		
Hardwood Pulpwood Removals	-0.47	0.95	0.94	1	
Total Hardwood Removals	-0.03	-0.29	-0.31	-0.17	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Removals*	*Total Removals*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.56	1			
Total Biomass Demand	0.99	0.61	1		
Total Pulpwood Removals	0.65	0.44	0.66	1	
Total Removals	0.00	0.50	0.04	0.60	1

***Table 38**. Georgia Catchment Area - Timber Inventory, Growth, Removals, & Mortality (2004-2018)*

Category	Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
				000 Cubic Meters			
Inventory	2018	132,720	75,209	74,926	62,636	45,816	391,335
	2017	124,281	74,614	76,370	59,805	44,061	379,131
	2016	118,024	72,349	76,823	56,945	42,928	367,096
	2015	114,795	73,113	79,343	55,217	41,880	364,321
	2014	110,916	72,802	82,826	55,869	43,466	365,907
	2013	107,433	70,961	82,826	55,784	44,259	361,235
	2012	102,393	69,319	83,987	56,945	45,335	358,007
	2011	98,400	66,572	84,072	57,030	45,363	351,437
	2010	96,135	65,638	86,026	57,681	45,703	351,211
	2009	92,142	64,222	87,810	57,256	44,740	346,142
	2008	90,556	63,542	88,999	58,587	45,165	346,878
	2007	87,527	61,787	86,904	57,794	45,590	339,601
	2006	88,688	61,843	87,668	59,861	46,552	344,613
	2005	87,470	59,805	86,054	56,916	44,712	334,957
	2004	85,261	56,520	84,525	57,766	46,439	330,511
Growth	2018	5,437	5,607	9,203	1,189	2,152	23,559
	2017	5,012	5,493	9,514	991	1,982	22,993
	2016	4,587	5,125	9,798	765	1,812	22,115
	2015	4,389	5,040	10,024	736	1,727	21,889
	2014	4,106	4,984	10,477	821	1,784	22,172
	2013	3,794	4,757	10,505	793	1,812	21,634
	2012	3,540	4,644	10,562	849	1,897	21,521
	2011	3,256	4,587	10,590	878	1,982	21,294
	2010	3,058	4,587	10,704	934	1,982	21,237
	2009	2,888	4,502	10,845	963	1,869	21,068
	2008	2,888	4,559	10,902	1,076	1,897	21,294
	2007	2,803	4,531	10,789	1,104	1,869	21,096
	2006	2,945	4,417	10,760	1,161	1,784	21,096
	2005	2,917	4,276	10,590	1,133	1,671	20,586
	2004	3,002	3,964	10,505	1,416	1,954	20,869
Removals	2018	5,324	5,692	8,665	623	821	21,124
	2017	4,870	5,267	6,598	595	963	18,264
	2016	4,644	4,984	6,796	566	849	17,839
	2015	4,163	4,672	6,994	680	991	17,471
	2014	3,568	4,616	7,249	510	849	16,792
	2013	3,568	4,757	7,447	708	906	17,358
	2012	3,681	4,757	7,334	708	736	17,188
	2011	3,936	5,267	7,617	1,104	963	18,887
	2010	3,823	5,069	6,994	1,218	906	18,038
	2009	4,049	4,701	6,569	1,529	1,133	17,981
	2008	3,964	4,502	6,116	1,472	1,161	17,188
	2007	4,191	4,757	6,258	1,727	1,416	18,349
	2006	4,417	4,502	5,918	1,501	1,388	17,726
	2005	4,672	4,559	5,833	1,586	1,642	18,293
	2004	4,672	4,417	5,380	1,614	1,671	17,754
Mortality	2018	708	368	566	623	595	2,860
	2017	623	340	566	680	651	2,888
	2016	623	396	623	708	708	3,058
	2015	595	453	708	765	736	3,256
	2014	595	453	708	765	708	3,228
	2013	595	453	708	765	680	3,171
	2012	566	425	708	793	651	3,143
	2011	595	396	651	793	566	3,002
	2010	595	340	595	821	481	2,832
	2009	538	340	623	765	481	2,775
	2008	510	311	623	736	510	2,690
	2007	481	283	595	708	481	2,520
	2006	425	283	538	680	453	2,407
	2005	425	255	510	595	453	2,265
	2004	453	255	481	538	481	2,180

Source: USDA - US Forest Service

6.1.7 *Changes in Raw Material Costs*

Historically, raw material purchases by Georgia Biomass and the Fram include a combination of pulpwood (roundwood), pulp quality chips, and sawmill residuals. However, in this section, pine and hardwood sawtimber prices are also examined to assess how these prices have changed and trended in the catchment area since 2000.

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

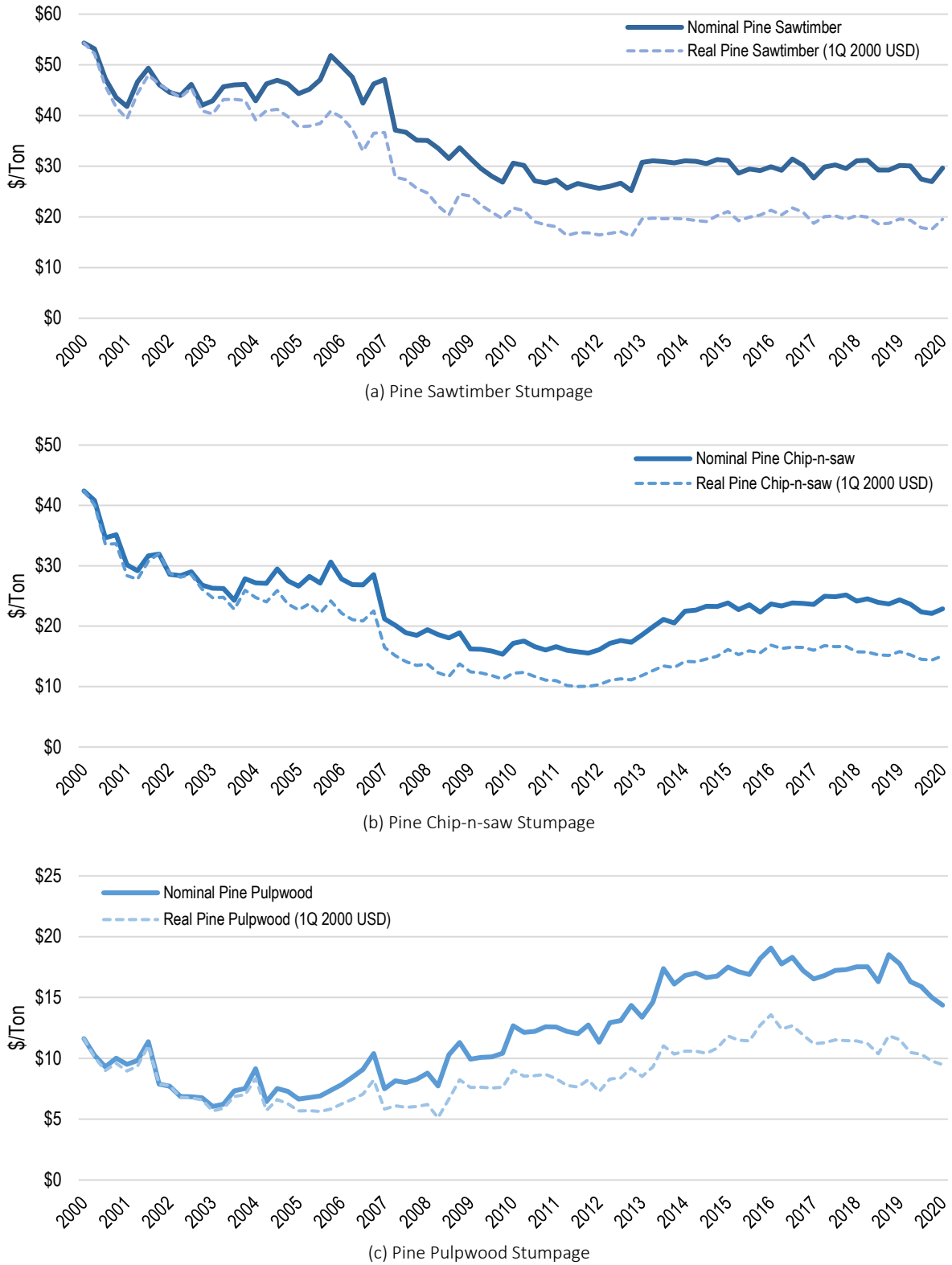
6.1.7.1 *Stumpage Prices*

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

- Pine Sawtimber Stumpage. Pine sawtimber (PST) stumpage prices held relatively steady and averaged $46.33 per ton from 1Q 2000-1Q 2007. However, PST stumpage prices proceeded to decline more than 45% over the six years that followed, bottoming out at $25.18 per ton in 4Q 2012. Prices rebounded a bit but since 2013 have held more-or-less flat and averaged $29.95 per ton, down 35% from the 1Q 2000-1Q 2007 average of more than $46 per ton.
- Pine Chip-n-saw Stumpage. Pine chip-n-saw (CNS) stumpage prices in the Georgia catchment area held steady and averaged $28.10 per ton from 2001-2006 before declining 45% over the three years that followed – to $ 15.36 per ton in 4Q 2009. CNS stumpage prices remained between $15-18 per ton from 4Q 2009-4Q 2012, rebounding to over $23 per ton in 3Q 2014. However, since 3Q 2014, CNS prices have held flat and averaged $23.65 per ton, down 16% from the 2001-2006 average of more than $28 per ton.
- Pine Pulpwood Stumpage. Pine pulpwood (PPW) stumpage prices declined from over $11 per ton in 1Q 2000 to roughly $6 per ton in 1Q 2003. However, PPW prices nearly tripled over the 10 years that followed, increasing an average of 10% per year to over $17 per ton in 3Q 2013. Prices have since leveled off, averaging $17.03 per ton from 3Q 2013 – 1Q 2020.
- Hardwood Sawtimber Stumpage. Hardwood sawtimber (HST) stumpage prices steadily increased from an average of roughly $18.50 per ton in 2000 to over $30 per ton in 2008 (+6.6% per year average). However, since 2008, HST stumpage prices have held steady (declined slightly) and averaged approximately $28.50 per ton in the Georgia catchment area.
- Hardwood Pulpwood Stumpage. Hardwood pulpwood (HPW) stumpage prices, although somewhat volatile, trended overall flat and averaged $8.28 per ton from 1Q 2000-1Q 2012 before increasing to over $13.50 per ton in 4Q 2013. However, HPW prices have steadily declined since, falling to below $8 per ton in 1Q 2020.

See Figures 49 and 50 for nominal and real quarterly average pine sawtimber, pine chip-n-saw, pine pulpwood, hardwood sawtimber, and hardwood pulpwood stumpage prices in the Georgia catchment area from 1Q 2000 – 1Q 2020. Corresponding prices are provided in tabular form in Appendix A.

***Figure 49**. Georgia Catchment Area – Nominal & Real Quarterly Pine Stumpage Prices ($/Ton)*

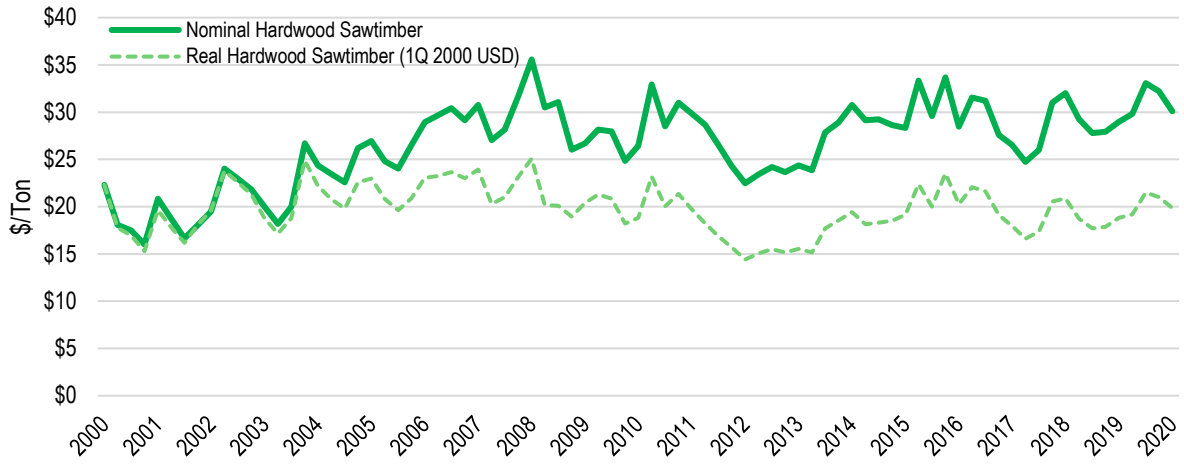


(a) Pine Sawtimber Stumpage

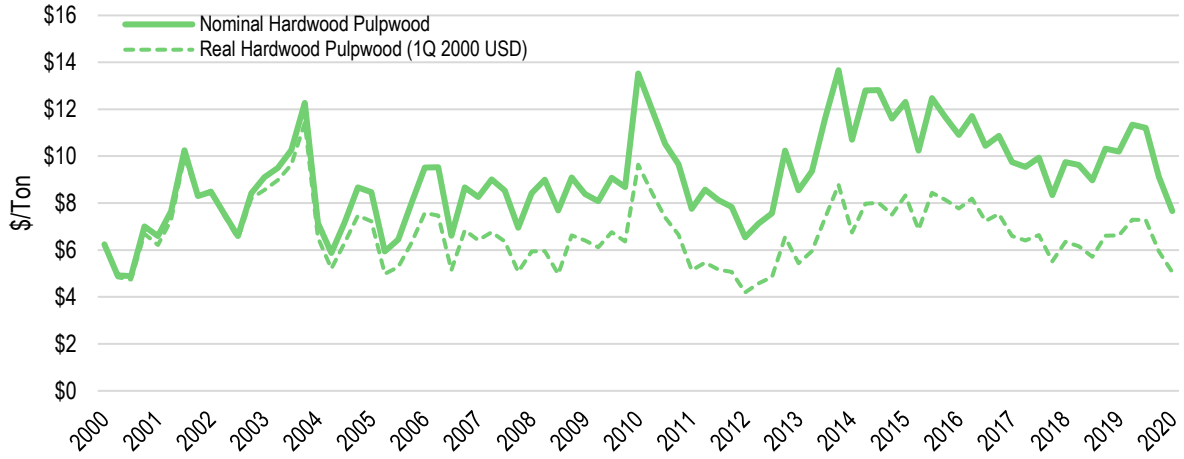
(b) Pine Chip-n-saw Stumpage

(c) Pine Pulpwood Stumpage

Figure 50. Georgia Catchment Area – Nominal & Real Quarterly Hardwood Stumpage Prices ($/Ton)



(a) Hardwood Sawtimber Stumpage



(b) Hardwood Pulpwood Stumpage

5.1.7.2 *Delivered Timber Prices*

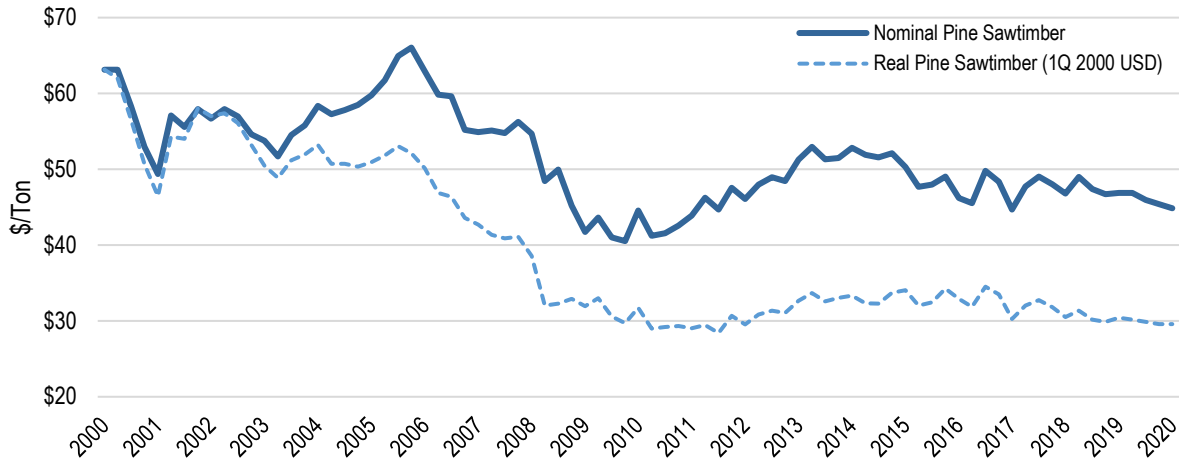
Delivered prices are those paid for timber delivered to the mill. These prices include stumpage (standing timber) price plus any costs associated with cutting, loading, and hauling timber to the mill.

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

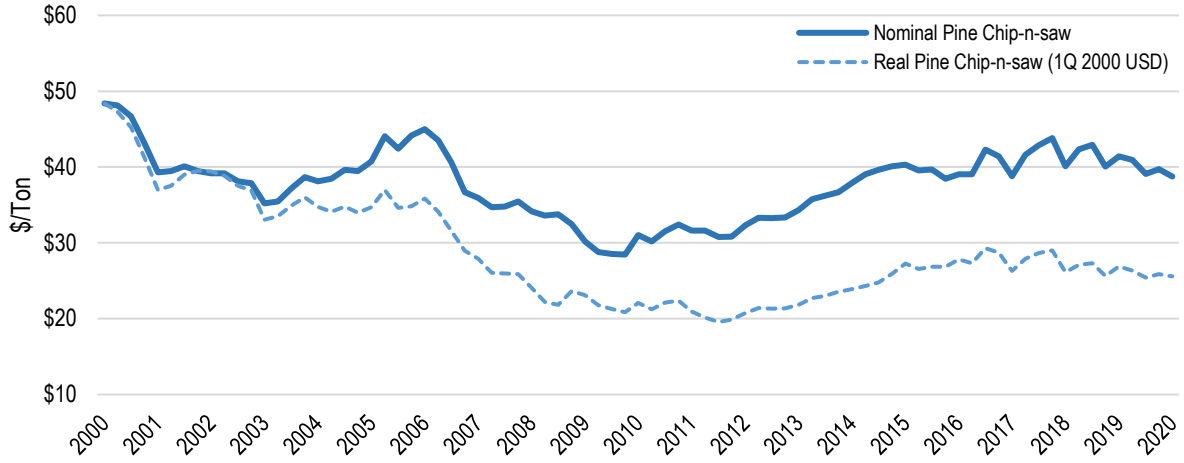
- Delivered Pine Sawtimber. Delivered pine sawtimber (PST) prices experienced a bit of volatility from 2000-2007 but overall trended flat and averaged more than $57 per ton over this period. However, prices fell 30% over the two years that followed, bottoming out at $40.53 per ton in 4Q 2009. Delivered PST prices proceeded to rebound to nearly $53 per ton in 2Q 2013 but since then have trended downward, decreasing an average of 2.5% per year and falling to $44.86 per ton in 1Q 2020.
- Delivered Pine Chip-n-saw. Delivered pine chip-n-saw (CNS) prices also experienced some volatility in the early to mid-2000s but ultimately averaged over $40 per ton from 2000-2006. Prices proceeded to decline 30% over the next several years, bottoming out at below $29 per ton in 4Q 2009. However, delivered CNS prices steadily increased over the five years that followed and since 4Q 2014 have averaged over $40 per ton.
- Delivered Pine Pulpwood. Delivered pine pulpwood (PPW) prices declined slightly in the early 2000s, falling 14% from $24.48 per ton in 1Q 2000 to $21.79 per ton in 1Q 2002. Prices proceeded to increase an average 3.8% per year (+74% total) over the next 14 years, to $37.81 per ton in 3Q 2016. However, delivered PPW prices have since declined approximately 16%, falling to $31.78 per ton in 1Q 2020.
- Delivered Hardwood Sawtimber. Delivered hardwood sawtimber (HST) prices have been on a steady upward trajectory since 2000. Specifically, delivered HST prices have increased an average of 3.0% per year from $26.60 per ton in 1Q 2000 to $48.45 per ton in 1Q 2020.
- Delivered Hardwood Pulpwood. Delivered hardwood pulpwood (HPW) prices, although a bit volatile, increased at an average rate of 3.3% per year (+59% total) from $20.94 in 1Q 2000 to $33.23 per ton in 2Q 2014. However, prices have since leveled out and averaged $31.46 per ton from 2Q 2014 – 1Q 2020.

See Figures 51 and 52 for nominal and real quarterly average pine sawtimber, pine chip-n-saw, pine pulpwood, hardwood sawtimber, and hardwood pulpwood delivered prices in the Georgia catchment area from 1Q 2000 – 1Q 2020. Corresponding prices are provided in tabular form in Appendix A.

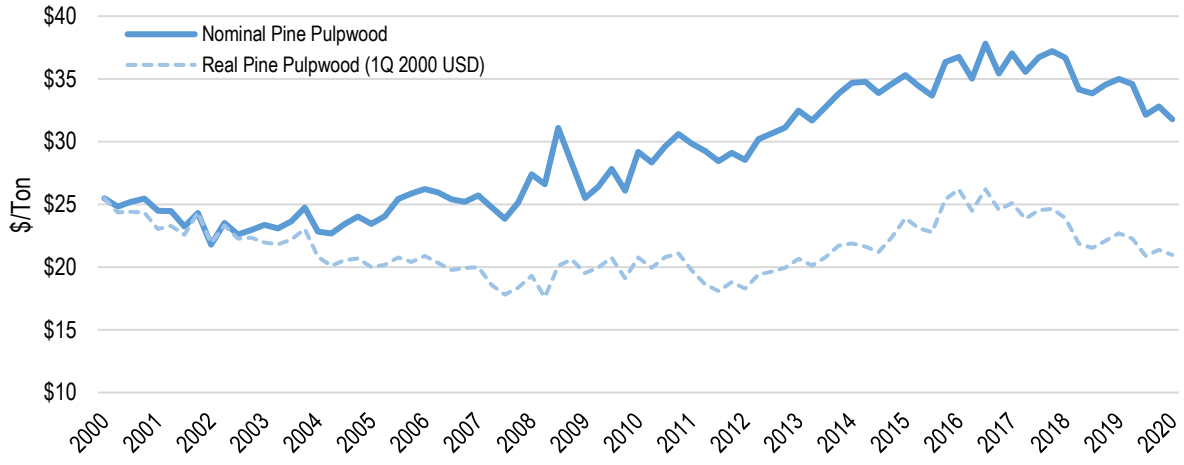
***Figure 51**. Georgia Catchment Area - Nominal & Real Quarterly Delivered Pine Prices ($/Ton)*



(a) Delivered Pine Sawtimber

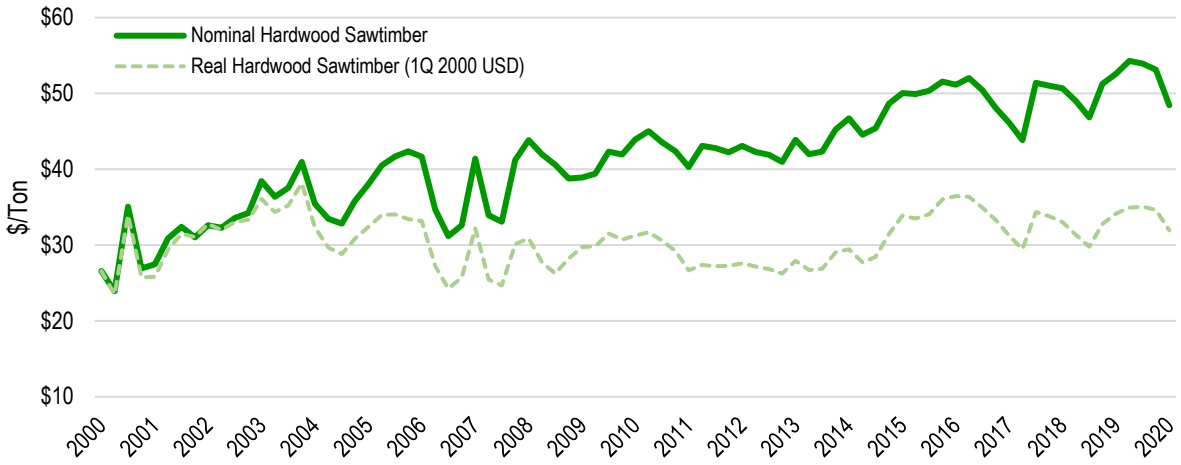


(b) Delivered Pine Chip-n-saw

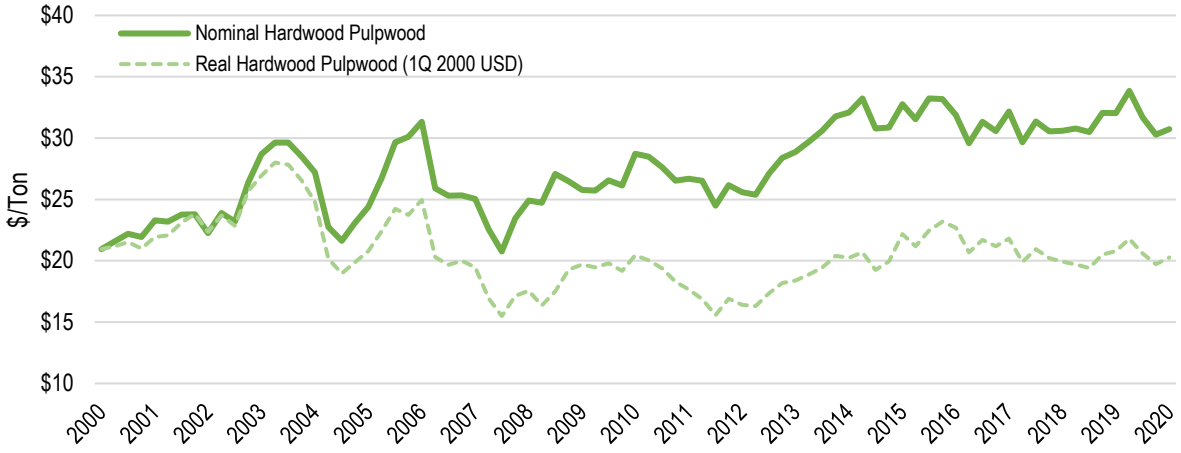


(c) Delivered Pine Pulpwood

***Figure 52**. Georgia Catchment Area - Nominal & Real Quarterly Delivered Hardwood Prices ($/Ton)*



(a) Delivered Hardwood Sawtimber



(b) Delivered Hardwood Pulpwood

5.1.7.3 *Pulp Quality Chip & Sawmill Residual Prices*

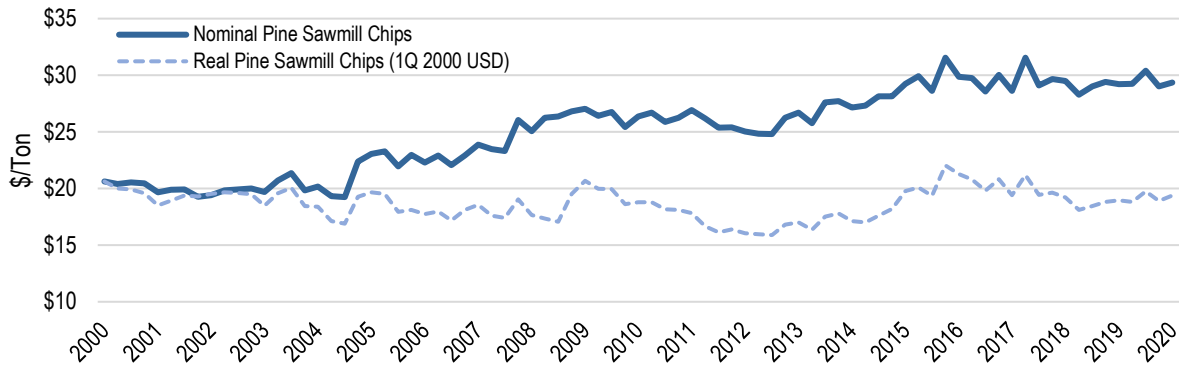
Pulpwood quality chips (FOB point of production) include both pine and hardwood sawmill chips (sawmill residuals) and pine and hardwood chip mill chips. Trends/changes with nominal chip and sawmill residual prices since 2000 are as follows:

- Pine Sawmill Chips (Sawmill Residuals). Pine sawmill chip prices held steady and averaged approximately $20 per ton from 1Q 2000 – 3Q 2004 before increasing an average of 4.1% per year (+58% total) to $31.55 per ton in 4Q 2015. Prices have since come down slightly but since 2016 have averaged $29.45 per ton.
- Pine Chip Mill Chips. Pine chip mill chip prices averaged approximately $26 per ton from 1Q 2000 – 3Q 2004 before increasing an average of 4.3% per year (+51% total) to $39.10 per ton in 1Q 2014. Prices proceeded to stabilize and average $38.90 per ton over the five years that followed. However, since 1Q 2019, pine chip mill chip prices have declined more than 20%, falling to $31.28 per ton in 1Q 2020.
- Hardwood Sawmill Chips (Sawmill Residuals). Prices for hardwood sawmill chips held steady and averaged $16.60 per ton from 1Q 2000 – 2Q 2002. However, prices have steadily increased an average of 2.9% per year (+67% total) to $27.74 per ton in 1Q 2020.
- Hardwood Chip Mill Chips. Hardwood chip mill chip prices increased from $23.50 per ton in 1Q 2000 to $38.75 per ton in 4Q 2010, or a 65% increased (+4.7% per year average) over this period. However, prices have since trended flat, averaging just below $37 per ton from 4Q 2010 – 1Q 2020.

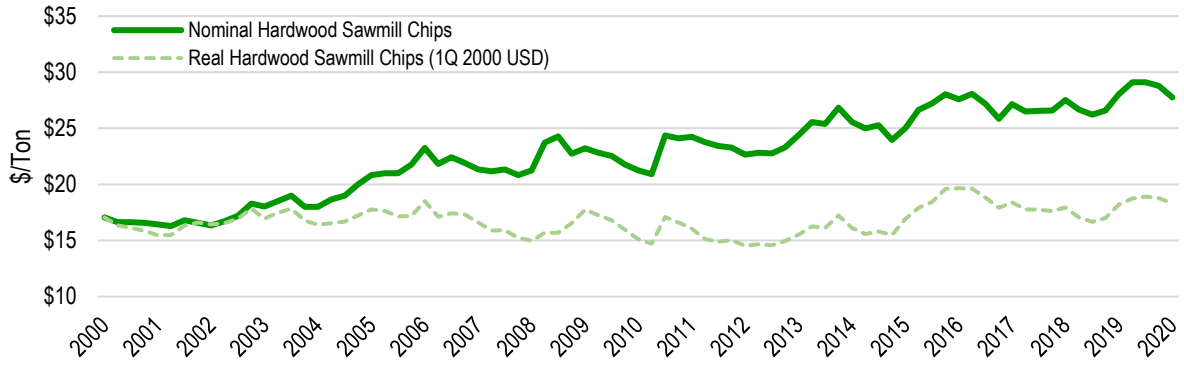
  In addition, we'd like to note that chip mill chip prices have historically remained above sawmill chip prices, with pine and hardwood chip mill chip prices averaging a 31% and 47% premium, respectively, over pine and hardwood sawmill chip prices since 2000.

See Figure 53 for nominal and real quarterly average prices for pine sawmill chips, pine chip mill chips, hardwood sawmill chips, and hardwood chip mill chips in the Georgia catchment area from 1Q 2000 – 1Q 2020. Corresponding prices are provided in tabular form in Appendix A.

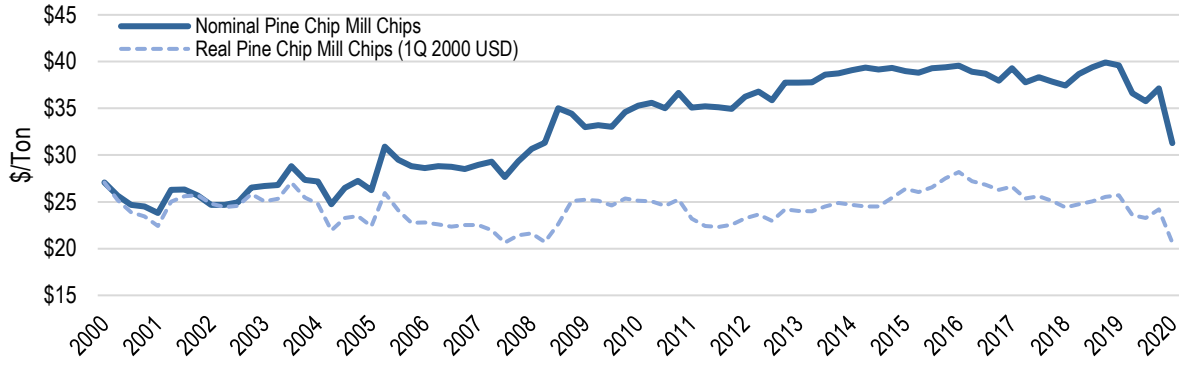
Figure 53. Georgia Catchment Area - Nominal & Real Quarterly Pulp Quality Chip Prices ($/Ton)



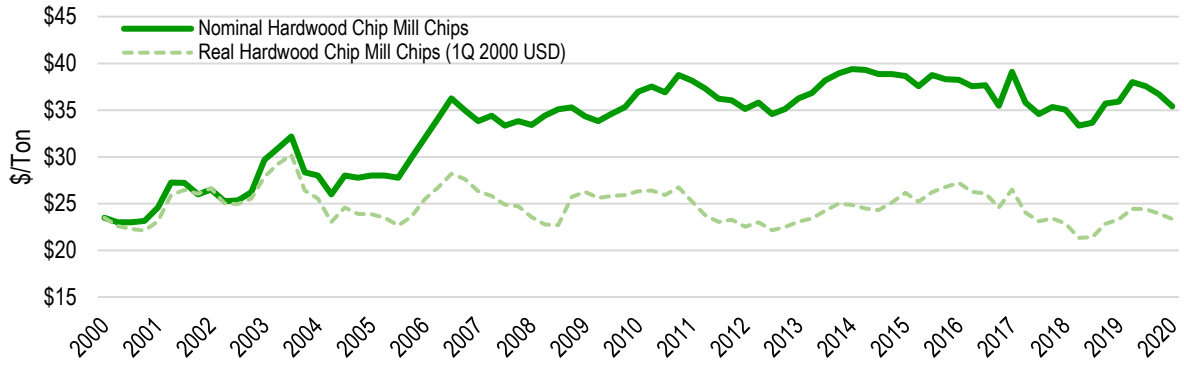
(a) Pine Sawmill Chips



(b) Hardwood Sawmill Chips



(c) Pine Chip Mill Chips



(d) Hardwood Chip Mill Chips

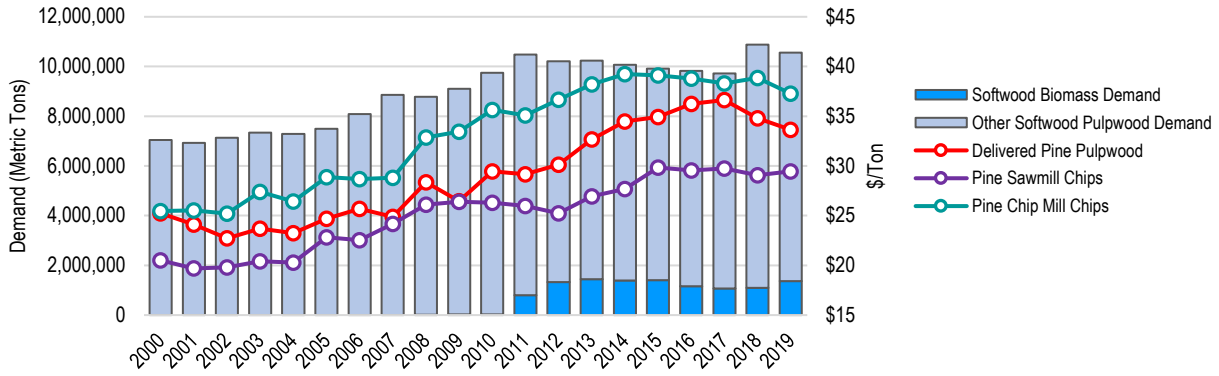
Correlation Analysis: *Biomass Demand vs. Raw Material Costs*

Historically, raw material purchases at Georgia Biomass and the Fram pellet mills have included a combination of predominantly softwood pulpwood (roundwood), pulp quality chips, and sawmill residuals. Specifically, softwood roundwood and residuals have constituted 86% of all raw materials consumed by these mills since 2012, compared to 14% for hardwood roundwood and residuals.

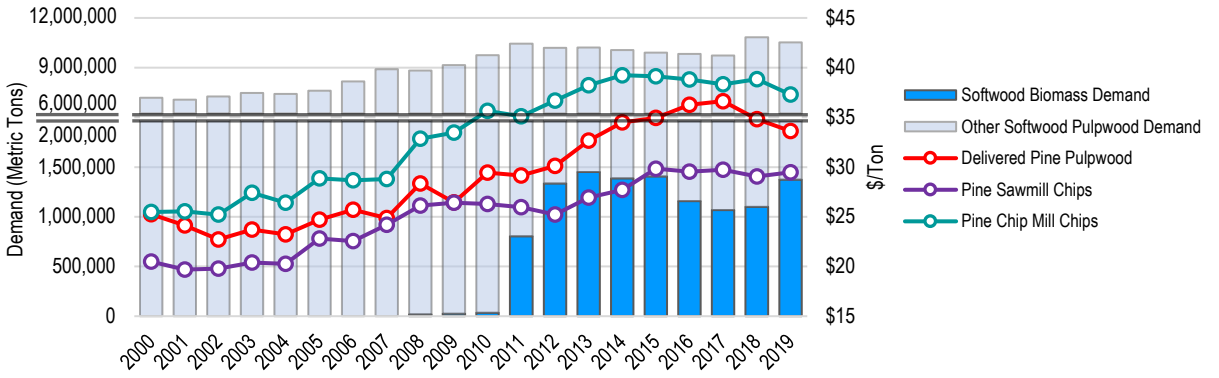
Figure 54 provides a side-by-side comparison of softwood biomass demand and total softwood pulpwood demand versus delivered pine pulpwood, pine sawmill chip, and pine chip mill chip prices in the catchment area from 2000-2019. Intuitively, we'd expect to see prices and demand moving in the same direction, and that's what this figure shows. Specifically, correlation analysis identified strong positive relationships between softwood pulpwood demand and each of these three pine raw material prices (see Table 39 on pg. 102). The same strong positive correlations were also found between softwood biomass demand and these raw material prices.

We'd like to point out that the bioenergy sector has likely had a larger impact on pine chip and pine residual prices in the Georgia catchment area. Specifically, total pine chip and pine residual purchases by Georgia Biomass and Fram have totaled more than 0.9 million metric tons annually since 2016, and the increase in demand for chips and other residuals appears to have resulted in an upward shift in the price levels of these raw materials.

***Figure 54**. Georgia Catchment Area – Softwood Pulpwood Demand vs. Delivered Pine Pulpwood, Pine Sawmill Chip, & Pine Chip Mill Chip Prices (2000-2019)*



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



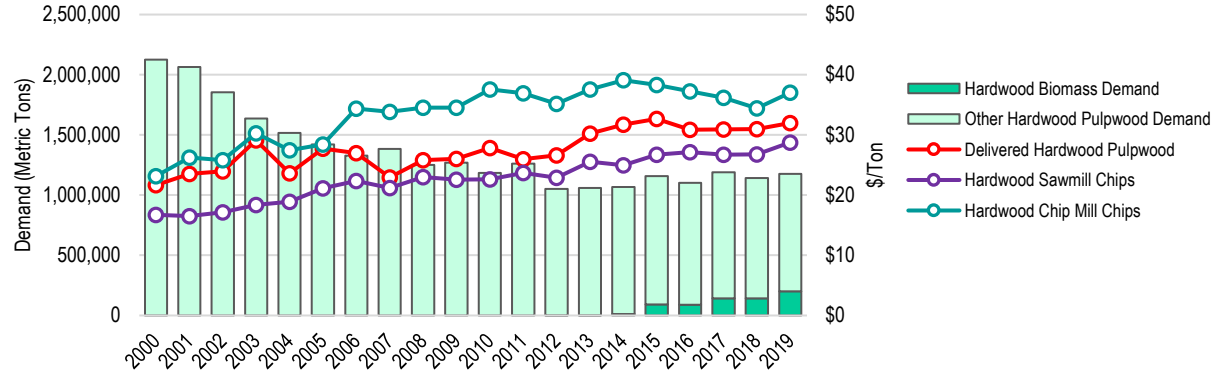
(b) Softwood Biomass Demand vs. Delivered Pine Pulpwood & Pine Chip Prices

Hardwood Pulpwood & Hardwood Chip Prices

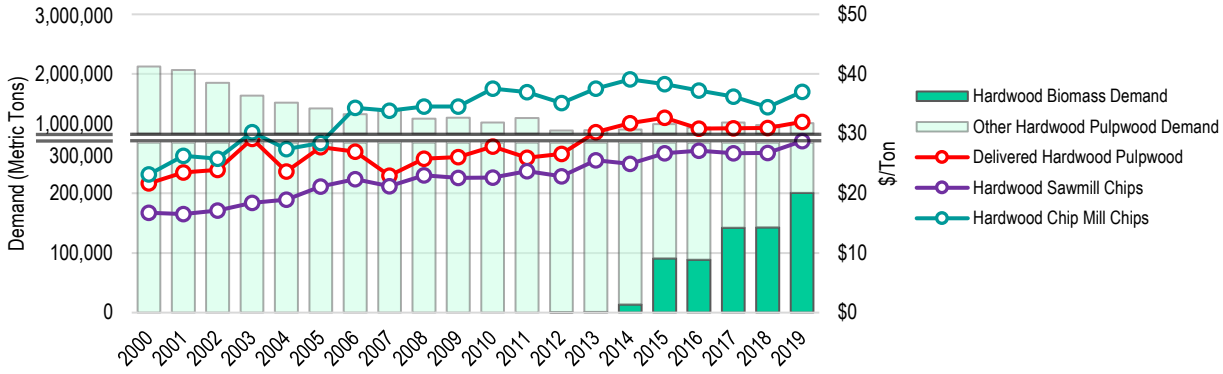
Figure 55 provides a side-by-side comparison of hardwood pulpwood demand and hardwood raw material prices in the catchment area since 2000. Looking at this figure, hardwood raw material costs have steadily increased since 2000. while demand for hardwood pulpwood has declined (but holding relatively level since 2012). Ultimately, statistical analysis identified strong negative correlations between hardwood pulpwood demand and hardwood raw material costs from 2000-2019 (see Table 40 on pg. 102). However, delivered hardwood pulpwood and hardwood sawmill chip prices were both found to have a moderately strong positive correlation to hardwood biomass demand over this period.

These moderately strong positive correlations do not provide enough evidence to suggest that increased hardwood pulpwood demand attributed to bioenergy is largely responsible for increased hardwood pulpwood and hardwood chip prices in the catchment area. While it is completely plausible that increased demand attributed to bioenergy has impacted these hardwood raw material prices, ultimately, hardwood biomass demand accounts for only a small proportion (10-20%) of total hardwood pulpwood demand in the Georgia catchment area.

***Figure 55**. Georgia Catchment Area – Hardwood Pulpwood Demand vs. Delivered Hardwood Pulpwood, Hardwood Sawmill Chip, & Hardwood Chip Mill Chip Prices (2000-2019)*



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



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

Sawtimber Prices

Pine and hardwood sawtimber prices were also examined to assess the impact biomass demand has had on markets for other solid wood products. Specifically, Figure 56 provides a side-by-side comparison of biomass demand versus delivered pine sawtimber, pine chip-n-saw, and hardwood sawtimber prices in the catchment area from 2000-2019.

Looking at this figure, prices of all three of these sawtimber products have generally followed total biomass demand since 2008. Correlation analysis confirms this – identifying moderately strong positive relationships between biomass and sawtimber prices from 2008-2019 (see Table 41 on pg. 102). However, note that these common trends appear to be more coincidental in nature, and there is little evidence to suggest that increases in biomass-related wood demand has caused these changes.

***Figure 56**. Georgia Catchment Area – Biomass Demand vs. Delivered Pine Sawtimber, Pine Chip-n-saw, & Hardwood Sawtimber Prices (2000-2019)*

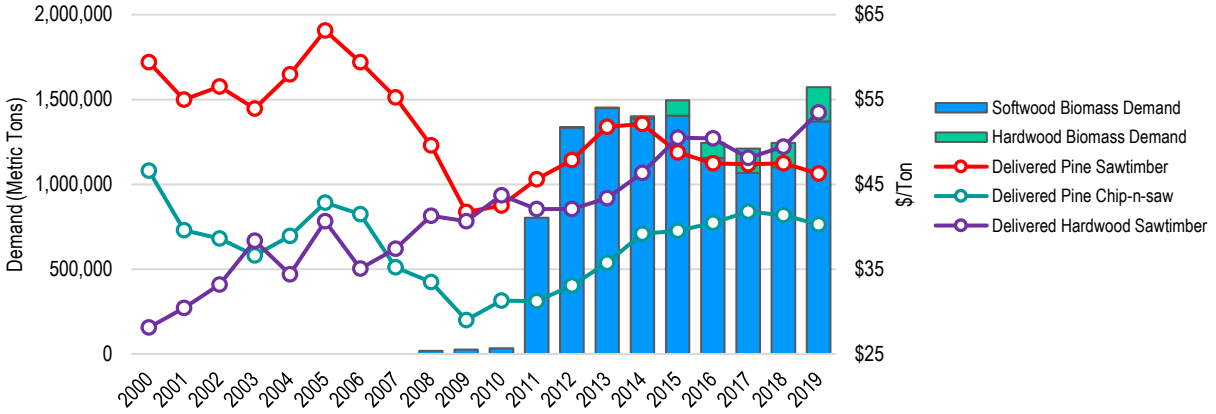
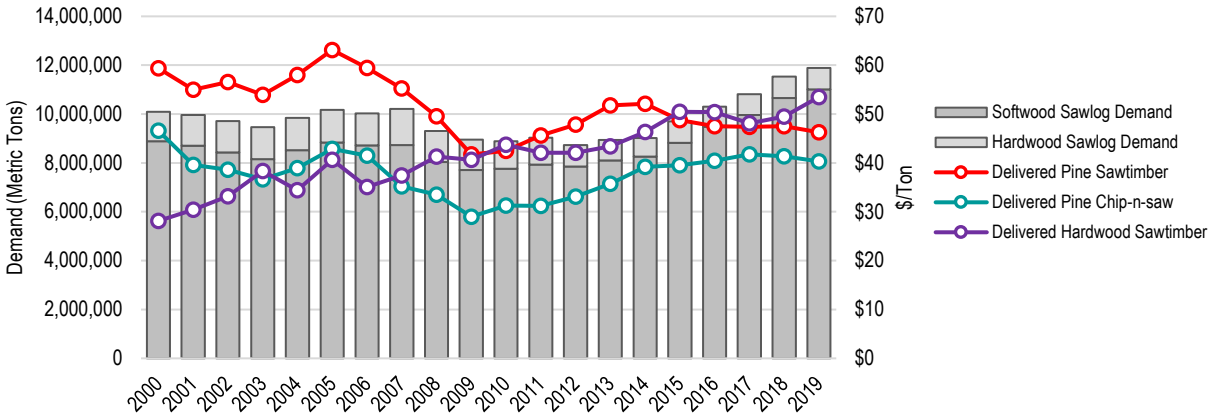


***Figure 57**. Georgia Catchment Area – Sawlog Demand vs. Delivered Pine Sawtimber, Pine Chip-n-saw, & Hardwood Sawtimber Prices (2000-2019)*



Changes in delivered pine sawlog prices, historically, have been largely driven by changes in softwood sawlog demand (see Figure 57 on the previous page). Specifically, strong positive correlations existed between softwood sawlog demand and both delivered pine sawtimber price (correlation coefficient=0.93) and delivered pine chip-n-saw price (correlation coefficient=0.88) from 2000-2014. However, we'd like to note that this relationship has fallen apart since 2014 – as delivered pine sawtimber and chip-n-saw prices have generally held flat despite demand for softwood sawlogs continuing to increase.

Specifically, softwood sawlog demand in the Georgia catchment area averaged 8.6 million metric tons per year from 2000-2007, falling to an average of less than 8.0 million metric tons per year from 2008-2014. This reduction in softwood sawlog demand allowed inventory levels to increase, which ultimately altered the balance of supply and demand in this market. As a result of this imbalance, delivered pine sawtimber and chip-n-saw prices have not responded to increases in softwood sawlog demand the last 5-7 years. Specifically, a strong negative relationship has existed between softwood sawlog demand and delivered pine sawtimber prices (correlation coefficient=-0.86) in the catchment area since 2014.

***Table 39**. Correlation Analysis – Softwood Biomass Demand, Delivered Pine Pulpwood Price, Pine Sawmill Chip Price & Pine Chip Mill Chip Price (2000-2019)*

	Softwood Biomass Demand	Other Softwood Pulpwood Demand	Total Softwood Pulpwood Demand	Delivered Pine Pulpwood Price	Pine Sawmill Chip Price	Pine Chip Mill Chip Price
Softwood Biomass Demand	1					
Other Softwood Pulpwood Demand	0.51	1				
Total Softwood Pulpwood Demand	0.81	0.91	1			
Delivered Pine Pulpwood Price	0.88	0.64	0.85	1		
Pine Sawmill Chip Price	0.77	0.80	0.90	0.93	1	
Pine Chip Mill Chip Price	0.86	0.79	0.94	0.94	0.95	1

***Table 40**. Correlation Analysis – Hardwood Biomass Demand, Delivered Hardwood Pulpwood Price, Hardwood Sawmill Chip Price & Hardwood Chip Mill Chip Price (2000-2019)*

	Hardwood Biomass Demand	Other Hardwood Pulpwood Demand	Total Hardwood Pulpwood Demand	Delivered Hardwood Pulpwood Price	Hardwood Sawmill Chip Price	Hardwood Chip Mill Chip Price
Hardwood Biomass Demand	1					
Other Hardwood Pulpwood Demand	-0.51	1				
Total Hardwood Pulpwood Demand	-0.36	0.99	1			
Delivered Hardwood Pulpwood Price	0.67	-0.77	-0.71	1		
Hardwood Sawmill Chip Price	0.72	-0.93	-0.87	0.84	1	
Hardwood Chip Mill Chip Price	0.38	-0.91	-0.92	0.73	0.87	1

***Table 41**. Correlation Analysis – Biomass Demand & Delivered Sawtimber Prices (2008-2019)*

	Softwood Biomass Demand	Hardwood Biomass Demand	Total Biomass Demand	Delivered Pine Sawtimber	Delivered Pine Chip-n-saw	Delivered Hardwood Sawtimber
Softwood Biomass Demand	1					
Hardwood Biomass Demand	0.44	1				
Total Biomass Demand	0.99	0.53	1			
Delivered Pine Sawtimber	0.63	0.00	0.60	1		
Delivered Pine Chip-n-saw	0.69	0.80	0.74	0.50	1	
Delivered Hardwood Sawtimber	0.59	0.90	0.66	0.17	0.87	1

***Table 42**. Correlation Analysis – Sawlog Demand & Delivered Sawtimber Prices (2000-2019)*

	Softwood Sawlog Demand	Hardwood Sawlog Demand	Total Sawlog Demand	Delivered Pine Sawtimber	Delivered Pine Chip-n-saw	Delivered Hardwood Sawtimber
Softwood Sawlog Demand	1					
Hardwood Sawlog Demand	-0.35	1				
Total Sawlog Demand	0.97	-0.11	1			
Delivered Pine Sawtimber	-0.03	0.54	0.11	1		
Delivered Pine Chip-n-saw	0.64	-0.10	0.65	0.61	1	
Delivered Hardwood Sawtimber	0.47	-0.76	0.29	-0.65	-0.09	1

5.2 Market Outlook: 2020-2022

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

- Enviva announced in 2Q 2020 that the expansion project at its Greenwood SC pellet facility remain underway, with completion expected by yearend. The expansion project, once complete, will increase annual production capacity from 550,000 to 660,000 metric tons of wood pellets. However, given the facility's location, no additional roundwood demand is expected to be place on the Georgia catchment area following the expansion.

  Separately, Enviva announced in June that the company had reached an agreement to acquire the Georgia Biomass pellet mill in Waycross GA. The change in ownership is not expected to impact roundwood demand attributed to this mill in the near term.

- Georgia-Pacific (GP) announced in 2Q 2020 that it had increased tissue production at its mill in Palatka FL. Separately, GP also announced market-related production curtailments at both its Cedar Springs GA and Perry FL pulp mills. The Palatka (Putnam County FL) and Perry (Taylor County FL) mills are located approximately 150-160 kilometers south/southwest of Georgia Biomass. The Cedar Springs mill is located approximately 240 kilometers north of Georgia Biomass in Early County GA.

  GP also announced in 4Q19 the startup of its new sawmill in Warrenton GA. The mill has a production capacity of 350 million bf of lumber per year. In addition, GP announced in March 2020 that its new sawmill in Dougherty County GA was almost fully operational. The $150 million facility has an annual production capacity of 300 million bf and is expected to startup in the second half of 2020.

  Based on these announcements and given the locations of these various facilities, we estimate a net reduction of 25,000-45,000 metric tons of roundwood (pulpwood) demand in the Georgia catchment area in 2020, but a net increase of 35,000-55,000 metric tons of roundwood demand in 2021 and 2022.

- Interfor announced in 3Q 2019 it had completed the Phase I project at its Meldrim GA sawmill, increasing annual production capacity to 135 million board feet (bf). The company also announced in May 2020 modifications to its previously-announced $240 million Phase II strategic capital, including the postponement of the sawmill operation rebuild at its Thomaston GA sawmill and deferral of the sawmill portion of the rebuild at its Eatonton GA mill (completion now planned for 2022).

  The increase in production associated with these upgrade projects is expected to add an estimated 45,000-55,000 metric tons per year of additional roundwood demand on the Georgia catchment area by 2022.

- Klausner ceased lumber production at its Klausner Lumber One sawmill in Live Oak FL in mid-March 2020. The company has announced it has no plans to restart the mill, which is currently for sale. The shutdown of the Klausner mill is expected to reduce roundwood demand in the Georgia catchment area by an estimated 345,000-380,000 metric tons in 2020, and an additional 70,000-90,000 metric tons in 2021 and 2022 should the mill remain shut down.

- Resolute Forest Products announced in 4Q 2019 the closure of its newsprint mill in Augusta GA. The mill, located approximately 190 kilometers north of Georgia Biomass in Richmond County, had a production capacity of 197,000 metric tons annually. Given the facility's location, the shutdown is expected to reduce roundwood demand in the catchment area by 90,000-115,000 metric tons annually beginning in 2020.

- West Fraser announced in early 2020 plans to build a new sawmill at its existing facility in Dudley GA, with startup planned for mid-2021. The new mill will increase site capacity from 100 to 250 million bf per year. The increase in production associated with this new replacement mill is expected to add an estimated 165,000-180,000 metric tons per year of additional roundwood demand on the catchment area by 2022.

5.2.1 *Wood Demand Outlook*

Based on the announcements highlighted on the previous page and other expected production changes, we anticipate total wood demand in the Georgia catchment area to decrease an estimated 4.0% from 2019 to 2020, due in large part to COVID-19 and its impact on general market conditions. However, we project wood demand to increase an average of 0.5% per year the following two years, to an estimated 22.9 million metric tons in 2022.

Demand for softwood and hardwood sawlogs is forecasted to decrease a combined 2.1% in 2020 but increase 0.3% from 2020-2022. Combined softwood and hardwood pulpwood demand is also forecasted to decline in 2020 (-6.0% Y/Y), followed by a 1.8% increase from 2020-2022.

***Table 43**. Georgia Catchment Area - Projected Wood Demand (2019-2022)*

Product	2019	2020	2021	2022
	Catchment Area – Annual Wood Demand (Metric Tons)			
Sawlogs:				
Softwood	11,010,083	10,744,936	10,677,906	10,752,530
Hardwood	886,781	907,098	922,686	934,577
Total Sawlogs	11,896,864	11,652,034	11,600,591	11,687,107
Pulpwood:				
Softwood	10,565,563	9,851,419	10,104,965	10,051,968
Hardwood	1,177,543	1,189,570	1,193,181	1,193,192
Total Pulpwood	11,743,105	11,040,989	11,298,145	11,245,161
Total	**23,639,969**	**22,693,024**	**22,898,737**	**22,932,268**

**projected*

***Table 44**. Georgia Catchment Area – Projected Biomass & Total Pulpwood Demand (2019-2022)*

Product	2019	2020	2021	2022
	Catchment Area – Pulpwood Demand (Metric Tons)			
Biomass Demand:				
Softwood Biomass	1,371,954	1,420,234	1,437,277	1,428,653
Hardwood Biomass	200,922	203,732	201,865	196,368
Total Biomass	**1,572,876**	**1,623,966**	**1,639,142**	**1,625,022**
Other Pulpwood Demand:				
Other Softwood Pulpwood	9,193,609	8,431,185	8,667,687	8,623,314
Other Hardwood Pulpwood	976,621	985,838	991,316	996,825
Total Other Pulpwood	**10,170,230**	**9,417,023**	**9,659,004**	**9,620,139**
Total Pulpwood Demand:				
Total Softwood Pulpwood	10,565,563	9,851,419	10,104,965	10,051,968
Total Hardwood Pulpwood	1,177,543	1,189,570	1,193,181	1,193,192
Total Pulpwood	**11,743,105**	**11,040,989**	**11,298,145**	**11,245,161**

**projected*

Figure 58. Georgia Catchment Area - Projected Wood Demand (2019 – 2022)

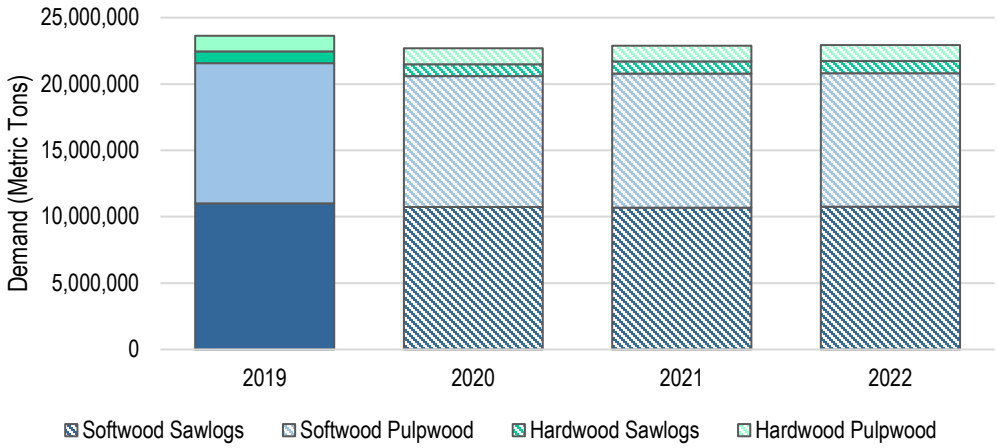
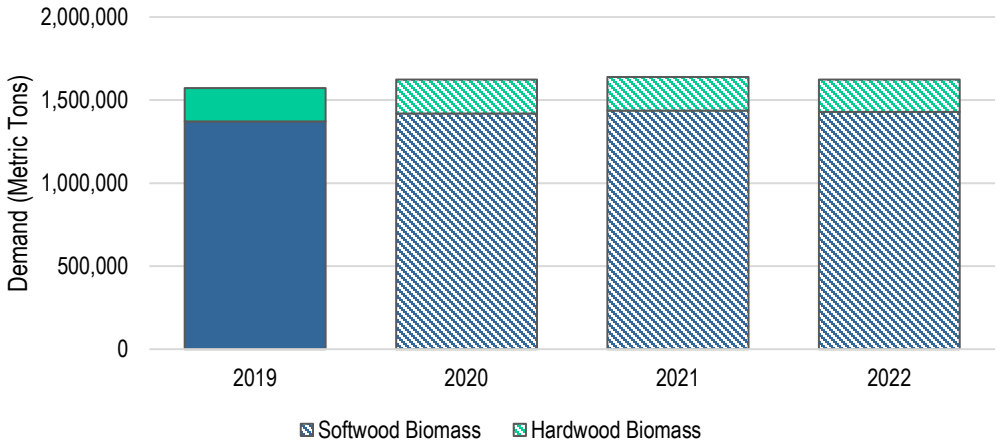


Figure 59. Georgia Catchment Area - Projected Biomass Demand (2019 – 2022)



5.2.2 *Raw Material Price Outlook*

Historically, raw material purchases for Georgia Biomass and Fram have predominantly included a mix of pine pulpwood (roundwood), pine chips, and pine sawmill residuals. Specifically, pine pulpwood constituted 42% of the total raw material purchases for these mills in 2019, with pine chips and secondary pine residuals accounting for an additional 42% of total purchases (84% total). Hardwood pulpwood, hardwood chips, and secondary hardwood residuals accounted for the remaining 16%.

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

Delivered pine pulpwood, pine sawmill chips, and pine chip mill chip price forecasts area as follows:

- Delivered Pine Pulpwood. Based on our analysis of raw material prices in the catchment area, including anticipated changes in biomass demand and total softwood pulpwood demand moving forward, we forecast a 4.2% decrease in delivered pine pulpwood (PPW) price from 2019 through 2022. Specifically, delivered PPW price is forecasted to fall 5.8% Y/Y in 2020 due to market conditions brought about by COVID-19. However, prices are forecasted to improve in 2021 and hold steady in 2022. Overall, delivered PPW prices are forecasted to average $32.10 per ton from 2020-2022, down 4.6% (-$1.537 per ton) from the 2019 average of $33.63 per ton.
- Pine Sawmill Chips. Pine sawmill chip prices are forecasted to decrease 3.9% from $29.47 per ton in 2019 to $28.32 per ton in 2020. However, we anticipate a modest increase in sawmill chip price in 2021, and for prices to hold steady and average $28.46 per ton in 2022. Overall, pine sawmill chip prices are forecasted to average $28.56 per ton from 2020-2022, down 3.1% (-$0.91 per ton) from the 2019 average.
- Pine Chip Mill Chips. As with pine pulpwood and pine sawmill chips, pine chip mill chip prices are also forecasted to fall in 2020 due to market conditions brought on by the COVID-19 pandemic. Specifically, chip mill chip prices are forecasted to fall 5.5% from $37.28 per ton in 2019 to $35.81 per ton in 2020. However, we anticipate a 1.6% increase in pine chip mill chip prices over the two years that follow, to $35.81 per ton in 2022. Overall, pine chip mill chip prices are forecasted to average $35.66 per ton from 2020-2022, down 4.3% (-$1.62 per ton) from the 2019 average.

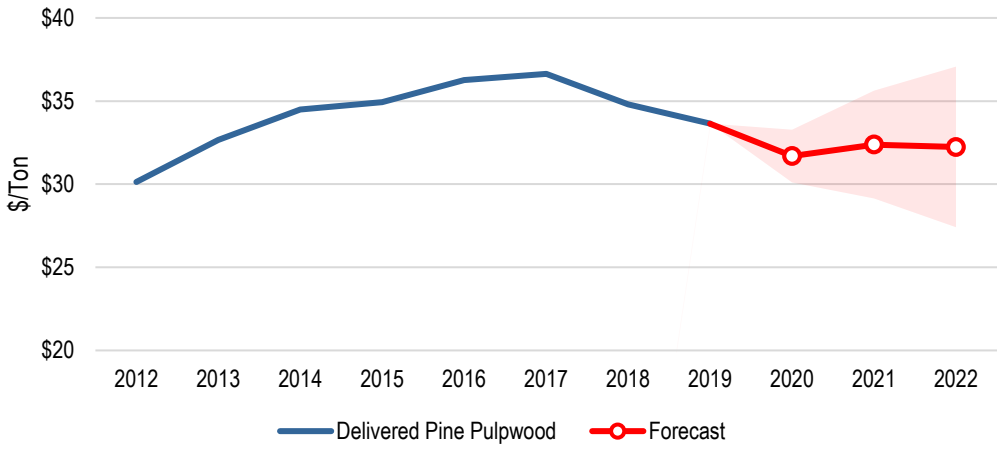
***Table 45**. Georgia Catchment Area - Forecasted Delivered Pine Pulpwood, Pine Sawmill Chip, & Pine Chip Mill Chip Prices (2020-2022)*

Year	Delivered Pine Pulpwood	Pine Sawmill Chips	Pine Chip Mill Chips
		($/Ton)	
2000	25.24	20.50	25.48
2001	24.12	19.69	25.53
2002	22.72	19.79	25.21
2003	23.71	20.40	27.41
2004	23.24	20.28	26.42
2005	24.70	22.82	28.87
2006	25.70	22.55	28.68
2007	24.87	24.18	28.81
2008	28.35	26.12	32.86
2009	26.45	26.41	33.46
2010	29.44	26.30	35.64
2011	29.16	25.97	35.09
2012	30.13	25.23	36.67
2013	32.67	26.94	38.22
2014	34.48	27.69	39.24
2015	34.94	29.84	39.12
2016	36.26	29.55	38.79
2017	36.63	29.74	38.32
2018	34.80	29.06	38.85
2019	33.63	29.47	37.28
2020	31.69	28.32	35.23
2021	32.38	28.73	35.96
2022	32.24	28.64	35.81

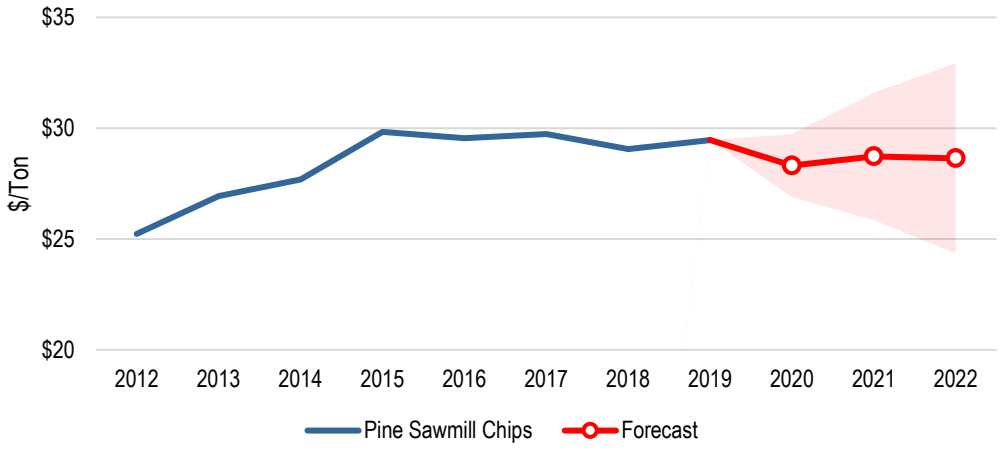
**forecasted*

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

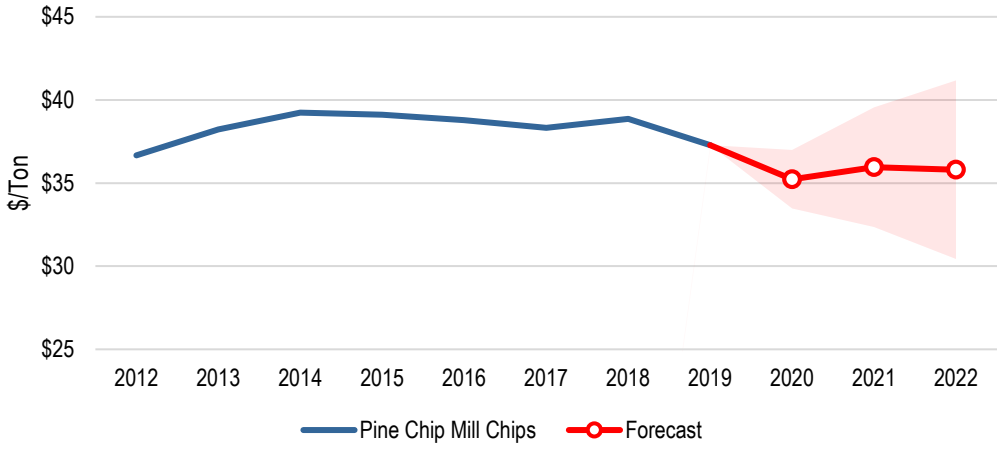
***Figure 60**. Georgia Catchment Area Price Forecasts: Delivered Pine Pulpwood, Pine Sawmill Chips, & Pine Chip Mill Chips (2020-2022)*



(a) Delivered Pine Pulpwood



(b) Pine Sawmill Chips



(c) Pine Chip Mill Chips

Table 46 provides a cost index (2019=100) of historic and forecasted per-unit pine raw material costs for the Georgia Biomass and Fram pellet mills from 2012 through 2022. These index values are based on the actual distribution of pine pulpwood, pine sawmill chips, and pine chip mill chips purchases by Georgia Biomass and Fram, as well as respective product prices, and are intended to show how average per-unit raw material costs have changed and are projected to change for these pellet mills over the next several years. Note that these index calculations are not based on actual raw material costs incurred by either Georgia Biomass or Fram, but rather based on average market prices in the Georgia catchment area.

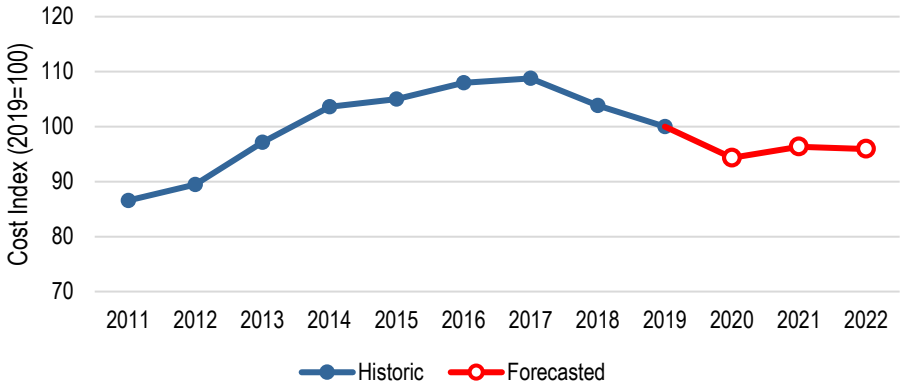
Average per-unit pine costs for pellet mills in the Georgia catchment area increased an estimated 22% from 2012-2017, or an average of 4.0% per year over this period. However, from 2017-2019, average per-unit costs declined 8%. Based on our forecasts and anticipated changes in product mix consumption, average per-unit pine raw material costs are projected to continue to decline in the Georgia catchment area, with the 2020-2022 average down 4.5% compared to 2019 levels.

***Table 46**. Georgia Catchment Area – Pine Raw Material Per-Unit Cost Index (2019=100)*

Year	Pine Raw Material Cost Index (2019 = 100)
2012	89
2013	97
2014	104
2015	105
2016	108
2017	109
2018	104
2019	100
2020	94
2021	96
2022	96

**forecasted*

***Figure 61**. Historic & Projected Raw Material Per Unit Index Cost (2019=100)*



6. Analysis Summary & Findings

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

- Changes in Forest Area

  According to the US Forest Service (USFS), the total area of timberland in the Georgia catchment area experienced a net decrease of 135,195 hectares (-3.3%) from 2000-2018, the latest available, decreasing from 4,130,223 to 3,995,028 hectares over this 18-year period. However, much of this decrease took place post-2011. Specifically, total timberland area held relatively steady (decreasing slightly) through the 2000s, averaging roughly 4,111,000 hectares from 2000-2011. However, from 2011-2018, total Georgia catchment area timberland declined an estimated 115,827 hectares, or a 2.8% decrease over this period. *(Note that the loss in timberland since 2011 coincided with a roughly 8,800-hectare increase in agricultural land and a roughly 93,000-hectare increase in urban land and land classified as having other uses. This loss was also due to some land reclassification, as forestland not classified as timberland increased roughly 13,900 hectares from 2011-2018.)*

  The composition of timberland in the catchment area has also undergone changes. Specifically, natural and planted hardwood timberland decreased a combined 155,894 hectares (-9.9%) from 2000-2018, the majority of which occurred from 2000-2009. However, planted pine timberland (the predominant supplier of pine pulpwood consumed by the pulp/paper and bioenergy industries in this market) increased an estimated 51,195 hectares (+3.3%) from 2000-2018. This increase in planted pine timberland coincided with a simultaneous 52,490-hectare decrease in natural pine timberland – suggesting that much of the natural pine timberland that was lost during this period was converted to more productive planted pine.

  Ultimately, combined planted and natural pine timberland (the predominant supplier of pine pulpwood in this market) has remained nearly unchanged in the catchment area since 2000 and been able to provide more than adequate supply to both the pulp/paper and bioenergy industries. Given that demand for pine pulpwood from the pulp/paper industry – bioenergy's primary roundwood competitor – has steadily declined since 2011 and that no substantial increases in demand are expected from Georgia Biomass or Fram over the next several years, adequate wood supply is expected to remain in the Georgia catchment area (at least over the short to mid-term).

➢ Changes in Timber Inventory, Growth, & Removals

According to USFS estimates, total growing stock inventory on timberland in the Georgia catchment area increased 19% from 328 million m^3 in 2000 to 391 million m^3 in 2018, or a net increase of over 63 million m^3 over this period. However, from 2008-2018, inventories of pine pulpwood, specifically, declined an estimated 14 million m^3 (-16%). Note that this decrease in pine pulpwood inventory was matched by a simultaneously 13 million m^3 increase in pine chip-n-saw inventory. This, along with observed changes in diameter class distribution since 2008, provide evidence of a catchment area forest that is not only aging but also in a state of transition, with pine pulpwood inventory moving up in product class to pine chip-n-saw.

The increase in total timber inventory reflected both trends in growth and removals in the catchment area, as total annual timber growth has outpaced total annual removals every year since 2004 – the first year that growth estimates were made available by the USFS. Specifically, total annual growth of growing stock timber increased 13% (+0.9% per year average) from 20.9 million m^3 in 2004 to 23.6 million m^3 in 2018. In comparison, total annual removals increased 19% (+1.3% per year average) over this same period, increasing from 18.0 million m^3 in 2004 to 21.1 million m^3 in 2018. However, much of this increase occurred in 2018 – due to Hurricane Michael, a Category 5 hurricane that hit the Florida Panhandle and traveled inland and through parts of the Georgia catchment area, causing significant damage to timberland along its path. Note that from 2004-2017, total annual timber removals increased an average of only 0.2% per year.

The decrease in pine pulpwood inventory since 2008 is less a reflection of growth and removal trends and more one of a forest in transition. Specifically, annual growth and removals of pine pulpwood decreased 10% and 13%, respectively, in the catchment area from 2011-2017. Typically, when growth exceeds removals, oversupply persists and inventory increases. However, in this case, pine pulpwood inventory declined. In the Georgia catchment area, removals of pine sawtimber declined 24% from 2005-2014 (due to the bursting of the US housing bubble and Great Recession that followed), and with the reduced harvest levels also came a reduction in newly-reestablished timber stands – the source of pine pulpwood. So, with less replantings occurring during this period, inventories of pine pulpwood were not replenished to the same degree they had been previously, and therefore this catchment area saw a reduction in pine pulpwood inventory levels.

In terms of long-term resource availability and market sustainability, in the Georgia catchment area, the ratio of total growth to total removals has remained above 1.0 since 2004. (Recall that a value of >1 indicates growth exceeds removals, signifying oversupply and sustainable harvest levels). The growth-to-removals ratio of pine pulpwood, specifically, held very consistent and averaged 1.44 from 2012-2017. However, that radio dropped significantly in 2018 (to 1.06) due to the substantial amount of salvage wood created by Hurricane Michael.

Overall, the impact of Hurricane Michael will likely be felt for several years, as this major storm cause some severe damage to parts of the Georgia catchment area. However, pine pulpwood inventory levels are expected to increase over the mid-to-long term as a result of increased pine sawtimber demand/production since 2012 (i.e. increased harvests of pine sawtimber have resulted in new replantings, which in turn will lead to increased inventories of pine pulpwood).

Changes in Wood Demand

Total wood demand in the Georgia catchment area increased an average of 2.0% per year (+19% total) from 2010 – the year prior to Georgia Biomass' startup – through 2019. Specifically, demand for softwood sawlogs and softwood pulpwood, which, combined, accounts for over 90% of total wood demand in the catchment area, increased 42% and 8%, respectively, over this period. The increase in softwood sawlog demand was due in large part to improved market conditions coming off the heels of the Great Recession. However, the increase in softwood pulpwood demand was largely attributed to increased demand from bioenergy (from Georgia Biomass and Fram).

Specifically, biomass-related softwood (pine) pulpwood demand increased from less than 19,000 metric tons in 2010 to over 1.3 million metric tons in 2012. Softwood biomass demand remained between 1.3 and 1.5 million metric tons per year from 2013-2015 but declined nearly 20% (to less than 1.2 million metric tons) in 2016 with the shutdown of E-Pellets' Nahunta GA pellet mill. Softwood biomass demand held between 1.0 and 1.2 million metric tons per year from 2016-2018 before increasing to nearly 1.4 million metric tons in 2019 – following Fram's purchase and restart of the former E-Pellets mill. Overall, the nearly 1.4 million metric ton increase in softwood pulpwood demand attributed to Georgia Biomass and Fram resulted in biomass-related pine pulpwood demand increasing from less than 0.5% of total catchment area pine pulpwood demand in 2010 to 13% of total pine pulpwood demand in 2019. Also worth noting is that non-biomass-related pine pulpwood demand decreased an estimated 5% from 9.7 million metric tons in 2010 to 9.2 million metric tons in 2019.

In terms of the short-term outlook, total pine pulpwood demand is projected to decrease 7% Y/Y in the Georgia catchment area in 2020 – back in line with pre-Hurricane Michael demand levels – but stabilize and average 10.1 million metric tons per year in 2021 and 2022. (Note that the impact of COVID-19 on production is also reflected in the decrease in demand in 2020). Specifically, softwood biomass demand is forecasted to decrease 2% from 2019-2022, compared to a 5% decrease in non-biomass-related softwood pulpwood demand over this same period. Ultimately, the anticipated decrease in total catchment area pine pulpwood demand the next several years is expected to result in reduced roundwood costs for Georgia Biomass and Fram Renewable Fuels.

Changes in Raw Material Prices

Raw material purchases for Georgia Biomass and the Fram pellet mills include a combination of roundwood, chips, and secondary wood residues. Specifically, pine pulpwood (roundwood) has accounted for 53% of total raw material purchases by these pellet mills since 2011, compared to 13% pine sawmill/chip mill/in-woods chips and 19% other secondary pine residuals (hardwood roundwood, chips, and secondary residuals have accounted for the remaining 14%).

In the Georgia catchment area, the price of delivered pine pulpwood increased from $29.44 per ton in 2010 (the year prior to Georgia Biomass' startup) to $36.63 per ton in 2017, or a 24% increase over this 7-year period. However, delivered pine pulpwood prices have declined 13% since 2017, falling to below $32 per ton in 1Q 2020. Note that this decrease in price was largely due to oversupply from salvage wood created by Hurricane Michael. Ultimately, delivered pine

pulpwood price increased 14% in the catchment area from 2010-2019, which coincided with an 8% increase in total pine pulpwood demand over this same period.

Pine sawmill chip prices held steady and averaged approximately $26 per ton in the Georgia catchment area from 2008-2012. However, prices increased more than 15% over the three years that followed, to $29.84 per ton in 2015. Pine sawmill chip prices have held steady since, averaging $29.53 per ton from 2015-2019. Pine chip mill chip prices followed a similar trend, increasing 7% from $36.67 per ton in 2012 to $39.12 per ton in 2015, but holding steady and averaging roughly $38.50 per ton since 2015. Note that the respective 15% and 7% increase in pine sawmill and pine chip mill chip prices from 2012-2015 coincided with a more than 200,000-ton increase in pine chip purchases by Georgia Biomass and Fram over this period.

The outlook for Georgia Biomass and Fram in terms of raw material costs is positive in the short term, with prices for all these three different pine products forecasted to decline slightly over the next several years. Specifically, delivered pine pulpwood, pine sawmill chips, and pine chip mill chips prices are all forecasted to decrease 3-4% in the catchment area from 2019-2022.

- Management/Harvest Trends

As part of this market analysis, Hood Consulting examined management practices to see how harvesting activities have changed in this market since 2000. Specifically, we wanted to assess whether landowners' approach to timber management changed with changing market conditions in this catchment area.

Clearcuts and thinnings are the two major types of harvests that occur in the region, both of which are long-standing, widely used methods of harvesting timber. TimberMart-South (TMS) data shows that thinnings accounted for 67% of total reported harvest area in the southeast Georgia market from 2000-2010, but only 43% of total reported harvest area from 2012-2019. Specifically, this downward shift was initiated by the bursting of the US housing bubble in the mid-2000s and had been completed by the early 2010s. We'd like to note that this shift coincided with a nearly 50% decrease in pine sawtimber stumpage prices from 2006-2012. This is important because the strength of pine sawtimber markets was a driving force behind timber management decisions in this region in the early and mid-2000s.

Also, contributing to the decreased prevalence of thinnings was the strengthening of pine pulpwood markets in the mid-2000s, as pine pulpwood stumpage prices increased more than 40% in the Georgia catchment area from 2003-2008. So, with sawtimber markets deteriorating rapidly and pulpwood markets doing just the opposite, many landowners decided to alter their management approach (to take advantage of strong pulpwood markets) and focus on short pulpwood rotations that typically do not utilize thinnings.

Ultimately, our assessment shows the shift in management approach that occurred in this market was due to the weakening of one type of timber market and the strengthening of another. In the early and mid-2000s, timber management was focused on sawtimber production – a type of management that utilizes thinnings. However, for more than a decade now, this market has been driven to a large degree by the pulp/paper industry, with a significant portion of the timber management in this area focused on short pulpwood rotations.

- Impact of Biomass Demand on Raw Material Prices

One of the important components of this analysis was to identify any relationships or linkages between changes in biomass demand and changes in raw material prices. Intuitively, an increase in demand should result in an increase in price, and this is what the data shows occurred in the Georgia catchment area as it relates to increased biomass demand from Georgia Biomass and Fram and changes in price of the various raw materials consumed by these mills.

Specifically, the 1.4 million metric tons of combined softwood pulpwood demand added by Georgia Biomass and Fram coincided with a 20% increase in delivered pine pulpwood price and a 10-15% increase in pine chip prices from 2011-2015. The apparent link between increased bioenergy demand and increased pine raw material prices was further supported by statistical analysis, as strong positive correlations were found between softwood biomass demand and both delivered pine pulpwood and pine chip prices. However, delivered pine pulpwood and pine chip prices were also found to have moderate-to-strong positive correlations to non-biomass-related pine pulpwood demand as well – suggesting that changes in these raw material prices are linked to changes in total softwood pulpwood demand (from both bioenergy and from other sources).

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

Appendix A. Quarterly Stumpage Prices, Delivered Timber Prices, & Pulp Quality Chip Prices (1Q 2000 – 1Q 2020)

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

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2000	1	54.33	42.41	11.62	22.29	6.25
2000	2	53.18	40.82	10.26	18.08	4.93
2000	3	47.24	34.65	9.29	17.50	4.89
2000	4	43.55	35.17	10.02	16.00	7.00
2001	1	41.79	30.14	9.52	20.86	6.60
2001	2	46.63	29.20	9.83	18.75	7.65
2001	3	49.33	31.66	11.38	16.64	10.26
2001	4	46.09	31.96	7.87	18.06	8.30
2002	1	44.55	28.60	7.72	19.48	8.48
2002	2	43.98	28.39	6.87	24.03	7.52
2002	3	46.14	28.99	6.85	22.93	6.59
2002	4	42.02	26.80	6.77	21.83	8.43
2003	1	42.90	26.30	6.04	20.00	9.11
2003	2	45.67	26.24	6.23	18.16	9.50
2003	3	46.02	24.26	7.32	20.00	10.27
2003	4	46.16	27.88	7.53	26.71	12.28
2004	1	42.91	27.17	9.16	24.36	7.16
2004	2	46.25	27.09	6.45	23.46	5.87
2004	3	46.98	29.49	7.53	22.57	7.20
2004	4	46.24	27.53	7.28	26.21	8.67
2005	1	44.31	26.64	6.66	26.94	8.47
2005	2	45.19	28.26	6.79	24.80	5.94
2005	3	47.05	27.14	6.91	24.03	6.45
2005	4	51.81	30.65	7.38	26.48	7.98
2006	1	49.75	27.83	7.84	28.94	9.52
2006	2	47.59	26.89	8.46	29.68	9.53
2006	3	42.45	26.83	9.08	30.41	6.61
2006	4	46.25	28.55	10.41	29.13	8.67
2007	1	47.11	21.21	7.50	30.76	8.26
2007	2	37.10	20.15	8.14	27.05	9.01
2007	3	36.68	18.93	8.02	28.17	8.53
2007	4	35.12	18.47	8.28	31.67	6.95
2008	1	35.06	19.43	8.80	35.58	8.43
2008	2	33.57	18.61	7.73	30.50	9.00
2008	3	31.50	18.05	10.29	31.07	7.69
2008	4	33.68	18.90	11.31	26.02	9.10
2009	1	31.51	16.25	9.94	26.70	8.38
2009	2	29.52	16.20	10.08	28.15	8.08
2009	3	28.03	15.89	10.13	27.96	9.07
2009	4	26.83	15.36	10.42	24.84	8.68
2010	1	30.61	17.16	12.68	26.44	13.53

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2010	2	30.16	17.55	12.13	32.94	12.03
2010	3	27.11	16.63	12.22	28.51	10.53
2010	4	26.71	16.06	12.60	30.99	9.65
2011	1	27.31	16.63	12.58	29.84	7.76
2011	2	25.68	16.00	12.21	28.68	8.58
2011	3	26.59	15.75	12.02	26.49	8.12
2011	4	26.07	15.55	12.75	24.29	7.84
2012	1	25.63	16.09	11.33	22.47	6.54
2012	2	26.06	17.15	12.93	23.42	7.12
2012	3	26.67	17.63	13.11	24.21	7.57
2012	4	25.18	17.32	14.34	23.66	10.24
2013	1	30.74	18.57	13.38	24.38	8.55
2013	2	31.06	19.89	14.63	23.85	9.37
2013	3	30.92	21.13	17.39	27.85	11.62
2013	4	30.67	20.52	16.12	28.89	13.67
2014	1	31.04	22.50	16.80	30.78	10.70
2014	2	30.95	22.67	17.02	29.15	12.80
2014	3	30.51	23.30	16.64	29.26	12.82
2014	4	31.34	23.25	16.76	28.64	11.60
2015	1	31.12	23.84	17.50	28.32	12.31
2015	2	28.63	22.75	17.12	33.33	10.24
2015	3	29.46	23.56	16.89	29.57	12.47
2015	4	29.14	22.31	18.21	33.68	11.65
2016	1	29.90	23.69	19.08	28.46	10.90
2016	2	29.17	23.35	17.75	31.53	11.72
2016	3	31.41	23.85	18.31	31.19	10.45
2016	4	30.15	23.76	17.21	27.57	10.87
2017	1	27.66	23.60	16.52	26.52	9.74
2017	2	29.86	24.98	16.81	24.75	9.54
2017	3	30.24	24.87	17.23	26.00	9.94
2017	4	29.52	25.17	17.30	30.99	8.34
2018	1	31.06	24.16	17.54	32.00	9.75
2018	2	31.16	24.54	17.54	29.28	9.62
2018	3	29.26	23.94	16.30	27.80	8.97
2018	4	29.25	23.67	18.53	27.92	10.32
2019	1	30.15	24.36	17.78	28.98	10.20
2019	2	30.03	23.66	16.30	29.81	11.34
2019	3	27.46	22.36	15.91	33.06	11.20
2019	4	26.96	22.10	15.01	32.23	9.12
2020	1	29.62	22.88	14.38	30.10	7.65

Source: TimberMart-South

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

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2000	1	63.15	48.40	25.48	26.60	20.94
2000	2	63.15	48.14	24.81	23.92	21.58
2000	3	58.33	46.69	25.19	35.06	22.19
2000	4	52.97	43.14	25.46	26.92	21.94
2001	1	49.39	39.32	24.49	27.46	23.30
2001	2	57.10	39.46	24.46	30.89	23.18
2001	3	55.58	40.11	23.23	32.40	23.77
2001	4	57.92	39.46	24.31	31.00	23.78
2002	1	56.68	39.19	21.79	32.61	22.24
2002	2	57.92	39.19	23.52	32.29	23.89
2002	3	56.96	38.14	22.61	33.58	23.20
2002	4	54.62	37.88	22.95	34.22	26.39
2003	1	53.74	35.20	23.37	38.43	28.69
2003	2	51.70	35.46	23.08	36.37	29.63
2003	3	54.53	37.20	23.64	37.55	29.63
2003	4	55.80	38.67	24.75	40.99	28.48
2004	1	58.36	38.12	22.84	35.44	27.21
2004	2	57.25	38.48	22.67	33.45	22.74
2004	3	57.81	39.63	23.43	32.83	21.61
2004	4	58.48	39.47	24.02	35.85	23.09
2005	1	59.76	40.72	23.45	38.03	24.38
2005	2	61.76	44.08	24.05	40.52	26.76
2005	3	64.95	42.41	25.42	41.69	29.67
2005	4	66.05	44.17	25.87	42.36	30.10
2006	1	62.93	44.99	26.23	41.66	31.33
2006	2	59.84	43.53	25.94	34.71	25.89
2006	3	59.64	40.63	25.41	31.21	25.31
2006	4	55.21	36.68	25.22	32.62	25.33
2007	1	54.89	35.91	25.71	41.41	25.03
2007	2	55.13	34.71	24.77	33.91	22.58
2007	3	54.79	34.77	23.86	33.09	20.76
2007	4	56.24	35.45	25.16	41.24	23.45
2008	1	54.69	34.15	27.40	43.84	24.92
2008	2	48.46	33.59	26.61	41.99	24.74
2008	3	49.95	33.77	31.09	40.58	27.07
2008	4	45.20	32.45	28.29	38.76	26.49
2009	1	41.75	30.19	25.51	38.91	25.76
2009	2	43.62	28.81	26.39	39.43	25.72
2009	3	41.03	28.54	27.82	42.31	26.56
2009	4	40.53	28.46	26.09	41.95	26.15
2010	1	44.56	31.01	29.18	43.93	28.73
2010	2	41.23	30.18	28.35	45.04	28.48
2010	3	41.58	31.53	29.62	43.55	27.62
2010	4	42.56	32.44	30.61	42.36	26.52
2011	1	43.87	31.64	29.84	40.30	26.69

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2011	2	46.26	31.62	29.25	43.07	26.53
2011	3	44.67	30.77	28.44	42.81	24.49
2011	4	47.55	30.81	29.12	42.23	26.17
2012	1	46.07	32.32	28.54	43.08	25.59
2012	2	48.00	33.33	30.21	42.29	25.39
2012	3	48.95	33.28	30.66	41.92	27.10
2012	4	48.45	33.37	31.12	40.99	28.37
2013	1	51.27	34.30	32.47	43.89	28.88
2013	2	52.97	35.76	31.68	42.01	29.71
2013	3	51.32	36.22	32.72	42.32	30.60
2013	4	51.48	36.68	33.81	45.24	31.78
2014	1	52.86	37.90	34.68	46.72	32.08
2014	2	51.90	39.07	34.76	44.55	33.23
2014	3	51.56	39.63	33.88	45.42	30.77
2014	4	52.13	40.09	34.61	48.65	30.87
2015	1	50.30	40.30	35.30	50.04	32.76
2015	2	47.68	39.57	34.43	49.93	31.53
2015	3	47.97	39.70	33.66	50.36	33.22
2015	4	49.02	38.46	36.36	51.58	33.19
2016	1	46.23	39.06	36.77	51.17	31.88
2016	2	45.54	39.07	35.01	52.04	29.58
2016	3	49.81	42.31	37.81	50.43	31.33
2016	4	48.37	41.40	35.44	48.07	30.57
2017	1	44.67	38.80	37.04	46.16	32.16
2017	2	47.74	41.61	35.55	43.86	29.65
2017	3	49.02	42.90	36.73	51.41	31.35
2017	4	48.04	43.81	37.22	51.03	30.54
2018	1	46.81	40.09	36.67	50.68	30.59
2018	2	49.01	42.34	34.15	49.00	30.79
2018	3	47.40	42.92	33.84	46.84	30.50
2018	4	46.74	40.06	34.53	51.27	32.06
2019	1	46.90	41.42	34.99	52.59	32.03
2019	2	46.87	40.94	34.60	54.29	33.85
2019	3	45.94	39.09	32.14	53.91	31.67
2019	4	45.42	39.72	32.81	53.15	30.28
2020	1	44.86	38.76	31.78	48.45	30.72

Source: TimberMart-South

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

Year	Quarter	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips
2000	1	20.63	17.04	27.09	23.50
2000	2	20.39	16.63	25.67	23.00
2000	3	20.54	16.63	24.67	23.00
2000	4	20.46	16.58	24.50	23.13
2001	1	19.67	16.42	23.81	24.57
2001	2	19.89	16.28	26.29	27.25
2001	3	19.93	16.79	26.33	27.21
2001	4	19.28	16.58	25.67	26.00
2002	1	19.42	16.33	24.67	26.50
2002	2	19.83	16.70	24.67	25.25
2002	3	19.92	17.21	24.96	25.33
2002	4	20.00	18.29	26.53	26.21
2003	1	19.69	18.04	26.68	29.68
2003	2	20.72	18.50	26.79	30.92
2003	3	21.35	19.00	28.83	32.17
2003	4	19.82	18.00	27.33	28.33
2004	1	20.18	18.00	27.17	28.00
2004	2	19.33	18.67	24.75	26.00
2004	3	19.24	19.00	26.50	28.00
2004	4	22.38	20.00	27.25	27.75
2005	1	23.07	20.83	26.25	28.00
2005	2	23.28	21.00	30.91	28.00
2005	3	21.96	21.00	29.50	27.75
2005	4	22.96	21.75	28.83	29.88
2006	1	22.29	23.25	28.63	32.00
2006	2	22.91	21.83	28.82	34.13
2006	3	22.08	22.42	28.75	36.25
2006	4	22.92	21.92	28.50	35.00
2007	1	23.86	21.33	28.95	33.83
2007	2	23.47	21.17	29.29	34.42
2007	3	23.32	21.33	27.67	33.33
2007	4	26.06	20.83	29.32	33.83
2008	1	25.06	21.25	30.67	33.42
2008	2	26.24	23.73	31.30	34.42
2008	3	26.37	24.27	35.01	35.08
2008	4	26.81	22.73	34.44	35.29
2009	1	27.05	23.21	32.99	34.34
2009	2	26.41	22.82	33.21	33.84
2009	3	26.76	22.54	33.02	34.62
2009	4	25.43	21.76	34.61	35.35
2010	1	26.37	21.24	35.28	36.99
2010	2	26.69	20.92	35.61	37.52
2010	3	25.87	24.35	35.01	36.90
2010	4	26.25	24.09	36.65	38.75

Year	Quarter	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips
2011	1	26.94	24.25	35.09	38.16
2011	2	26.20	23.77	35.21	37.33
2011	3	25.36	23.43	35.11	36.22
2011	4	25.40	23.29	34.95	36.06
2012	1	25.02	22.65	36.23	35.11
2012	2	24.84	22.81	36.80	35.80
2012	3	24.81	22.76	35.88	34.59
2012	4	26.25	23.31	37.76	35.11
2013	1	26.71	24.38	37.76	36.24
2013	2	25.76	25.56	37.77	36.84
2013	3	27.59	25.39	38.60	38.17
2013	4	27.71	26.83	38.75	38.93
2014	1	27.16	25.56	39.10	39.39
2014	2	27.31	24.99	39.36	39.30
2014	3	28.14	25.26	39.16	38.84
2014	4	28.14	23.96	39.33	38.84
2015	1	29.23	25.01	39.00	38.64
2015	2	29.93	26.65	38.80	37.54
2015	3	28.63	27.22	39.28	38.76
2015	4	31.55	28.03	39.39	38.32
2016	1	29.86	27.59	39.58	38.23
2016	2	29.75	28.07	38.90	37.57
2016	3	28.56	27.17	38.72	37.65
2016	4	30.03	25.83	37.94	35.46
2017	1	28.63	27.15	39.28	39.09
2017	2	31.55	26.49	37.80	35.80
2017	3	29.10	26.56	38.33	34.57
2017	4	29.66	26.59	37.86	35.33
2018	1	29.49	27.53	37.43	35.06
2018	2	28.29	26.67	38.68	33.34
2018	3	29.02	26.20	39.40	33.65
2018	4	29.42	26.59	39.91	35.71
2019	1	29.22	28.04	39.60	35.92
2019	2	29.25	29.10	36.61	37.99
2019	3	30.39	29.10	35.78	37.55
2019	4	29.02	28.78	37.14	36.69
2020	1	29.36	27.74	31.28	35.40

Source: TimberMart-South

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

Log Rule and Weight Equivalents

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

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

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

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

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

English & Metric Conversions

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

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

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

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

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

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

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

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

1 acre = 0.405 hectares

1 mile = 1.609 kilometers

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

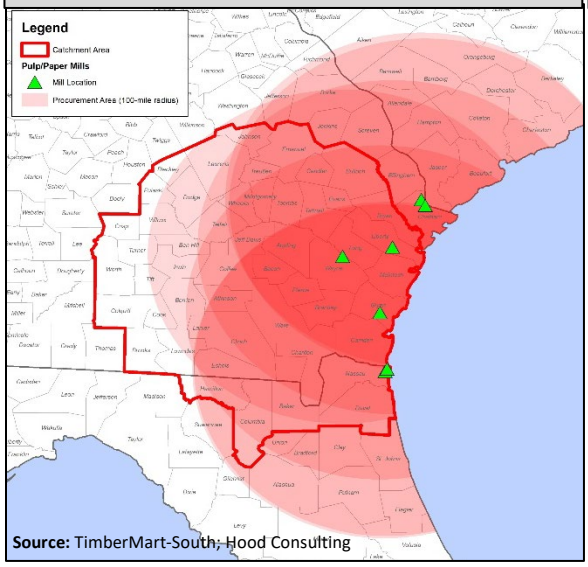
Annex 1. Test Analysis - Pine Pulpwood Stumpage Prices:
Coastal vs. Interior Region

As was noted in the Georgia catchment area analysis report, the eastern portion of this catchment area along the Atlantic Coast contains a high concentration of pulp/paper mills. Specifically, there are seven pine pulpwood-consuming pulp/paper mills located along the Atlantic Coast between Jacksonville FL and Savannah GA, which together consume an estimated 6-8 million tons of roundwood (pine pulpwood) annually. As a result of this high level of mill concentration, and with the Atlantic Ocean serving as a barrier to the east, competition amongst these pulp/paper mills for pulpwood is inherently high in the eastern portion of the Georgia catchment area.

The figure below, on the left, identifies the locations of these pulp/paper mills and provides an overlay of the approximate catchment areas of each of these mills (100-mile radius) to illustrate the competitiveness of this market. Specifically, this figure indicates that competition for pine pulpwood from these mills is extremely high in the eastern half of the catchment area. However, to confirm this assertion, we took a closer look at how pine pulpwood prices vary throughout this catchment area.

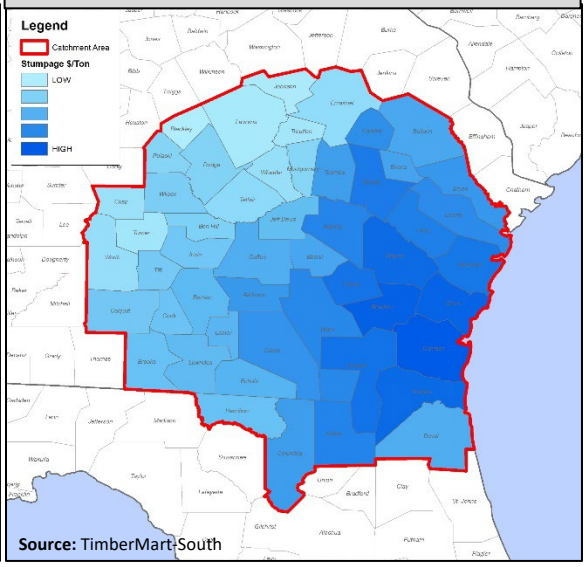
The figure below, on the right, shows county-level average pine pulpwood stumpage prices in the Georgia catchment area from 2Q 2019 – 1Q 2020 (provided by TimberMart-South). In comparing this figure to the one identifying pulp/paper mill competition levels, notice that prices are highest in those same areas where competition appears highest.

Georgia Catchment Area: *Pulp/Paper Mill Concentration Along the Atlantic Coast*



Source: TimberMart-South; Hood Consulting

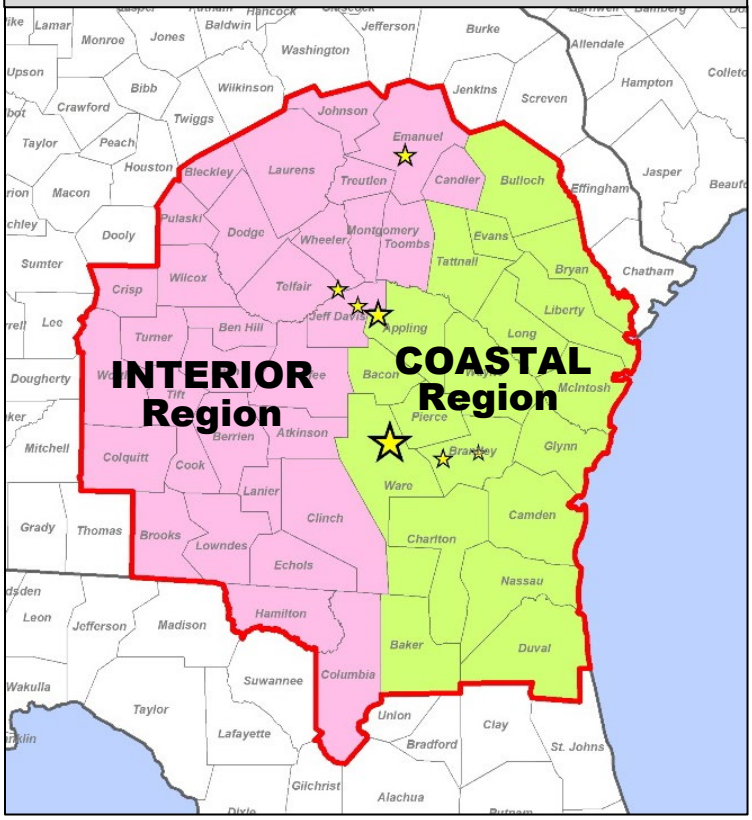
Georgia Catchment Area: *Pine Pulpwood Stumpage Price (Avg. 2Q19-1Q20)*



Source: TimberMart-South

Given these initial findings, we decided to look further at pine pulpwood prices in the Georgia catchment area. Specifically, we took a closer look at how prices and price trends of pine pulpwood, the primary roundwood product consumed by these pulp/paper mills (as well as by Georgia Biomass and Fram), have historically differed in the '**Coastal**' and '**Interior**' regions of the Georgia catchment area (see figure below).

Georgia Catchment Area: Coastal vs. Interior Region



Source: Hood Consulting

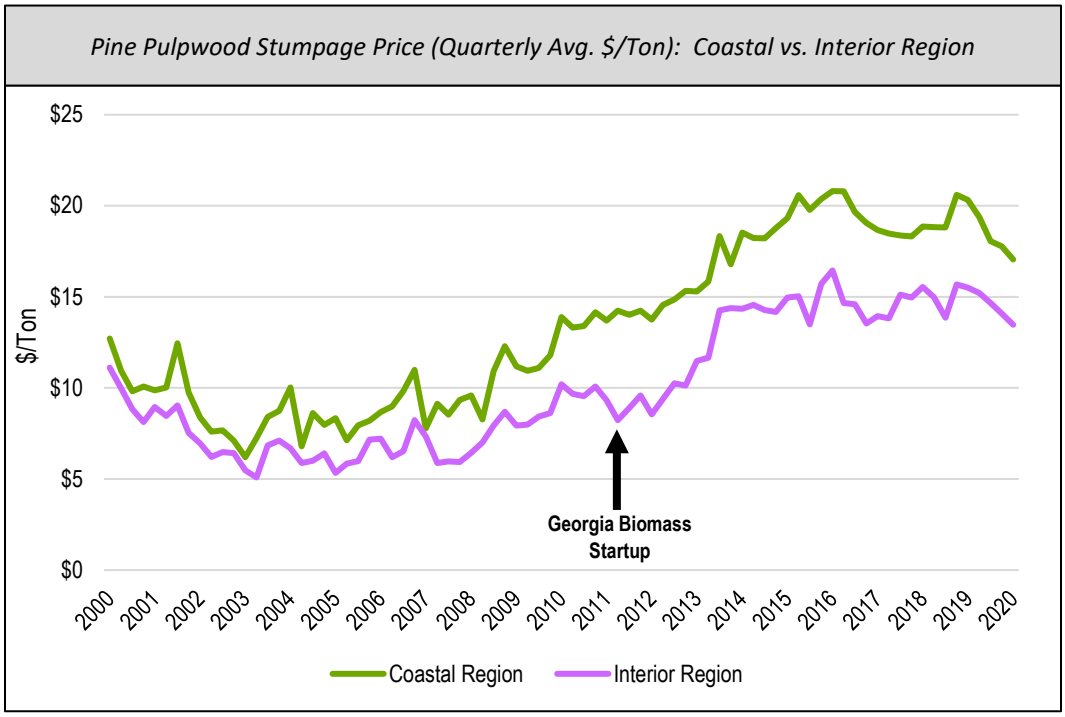
Coastal vs. Interior Pine Pulpwood Stumpage Prices

According to TimberMart-South, pine pulpwood (PPW) stumpage prices, overall, have trended similarly in the Coastal and Interior regions of the Georgia catchment area since 2000 (see figure on following page). Specifically, these prices have a high positive correlation to one another (correlation coefficient=0.97 from 1Q00-1Q20). However, we'd like to point out two key observations. First, PPW stumpage prices have remained higher in the Coastal Region. And second, the gap between PPW stumpage prices in these two regions has widened since Georgia Biomass started up in 2Q 2011.

Specifically, PPW stumpage prices in the Coastal Region averaged a 30% premium over those in the Interior Region from 1Q 2000 – 1Q 2011. However, that gap widened substantially during the two years that immediately followed Georgia Biomass' startup, with Coastal Region PPW stumpage prices averaging a 55% premium over Interior Region PPW stumpage prices from 2Q 2011-1Q 2013 (and an overall

average premium of 35% since 2Q 2011). Adjusting for inflation, real PPW stumpage prices averaged $1.84 per ton higher in the Coastal Region from 1Q 2000-1Q 2011 compared to $2.94 per ton higher from 2Q 2011-1Q 2020.

Ultimately, this data and these findings seem to indicate that the pulp/paper mills located in the Coastal Region of the catchment area were/are willing to pay more for close-proximity wood fiber. As a result, Georgia Biomass and Fram have placed a higher focus on procuring roundwood from the less competitive western portion of the catchment area (a strategy confirmed by both Georgia Biomass and Fram personnel). Furthermore, the additional wood demand placed on the catchment area (primarily on the western portion) by Georgia Biomass and Fram was not sufficient enough to narrow the gap between pine pulpwood prices in the Interior Region versus those in the Coastal Region.



Source: TimberMart-South

Note that delivered timber prices are unavailable for these two smaller subregions due to data limitations and the limited number of contributing TimberMart-South data reporters (to protect reporter confidentiality). However, note that in the Georgia catchment area, pine pulpwood stumpage prices have a strong positive correlation to and are highly indicative of delivered pine pulpwood prices.

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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