LaSalle, Louisiana Catchment Area Analysis

June 2020

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Executive Summary

This memo provides summary analysis of a timber market defined in cooperation with Drax Biomass International (Drax) and located in southern Louisiana and western Mississippi. The LaSalle Market features both abundant pine timber supplies and balanced hardwood supplies. Private timberland owners account for 83% of the timber inventory in the area, and nearly 60% of this area is owned by corporate owners (e.g. investment managers, REITs, and corporations) with cash flow expectations. The market features industrial, diversified mills and recent investments in sawmills and pulpwood-using facilities. Pellet producers use 5.8% of the roundwood used by the forest products industry in the market; LaSalle BioEnergy uses 3.2% of the roundwood in the market. Roundwood pulpwood consumption is concentrated in the pulp and paper sector, which represents 74% of pulpwood demand. Prices for all pine sawtimber and pulpwood have declined since 2010; ample pine supplies softened prices although chip-n-saw prices increased 25%. Hardwood prices increased over this time frame with upward pressure from tighter supplies.

Overall, bioenergy markets have not directly impacted forest management activities or forest supplies in the LaSalle Market (Figures 1 and 2). Bioenergy markets benefit timberland owners by adding outlets for wood in the region. Likewise, bioenergy plants that purchase sawmill residuals benefit solid wood markets as access to residual markets is a limiting factor to the expansion of lumber facilities.

Figure 1. Bioenergy Impacts on Markets and Forest Supplies in the LaSalle Market

Activity	Is There Evidence That Bioenergy Demand Has Caused the Following?	Explanation
Deforestation	No	
Change in Forest Management Practices	No	
Diversion from Other Markets	Possibly	Bioenergy plants compete with pulp/paper and OSB mills for pulpwood and residual feedstocks. There is no evidence that these facilities reduced production as a result of bioenergy markets, however.
Increase in Wood Prices	No	There is no evidence that bioenergy demand increased stumpage prices in the market.
Reduction in Growing Stock of Timber	No	
Reduction in Sequestration of Carbon / Growth Rate	No	
Increase in Harvesting Above the Sustainable Yield	No	

Figure 2. Bioenergy Impacts on Forests Markets in the LaSalle Market

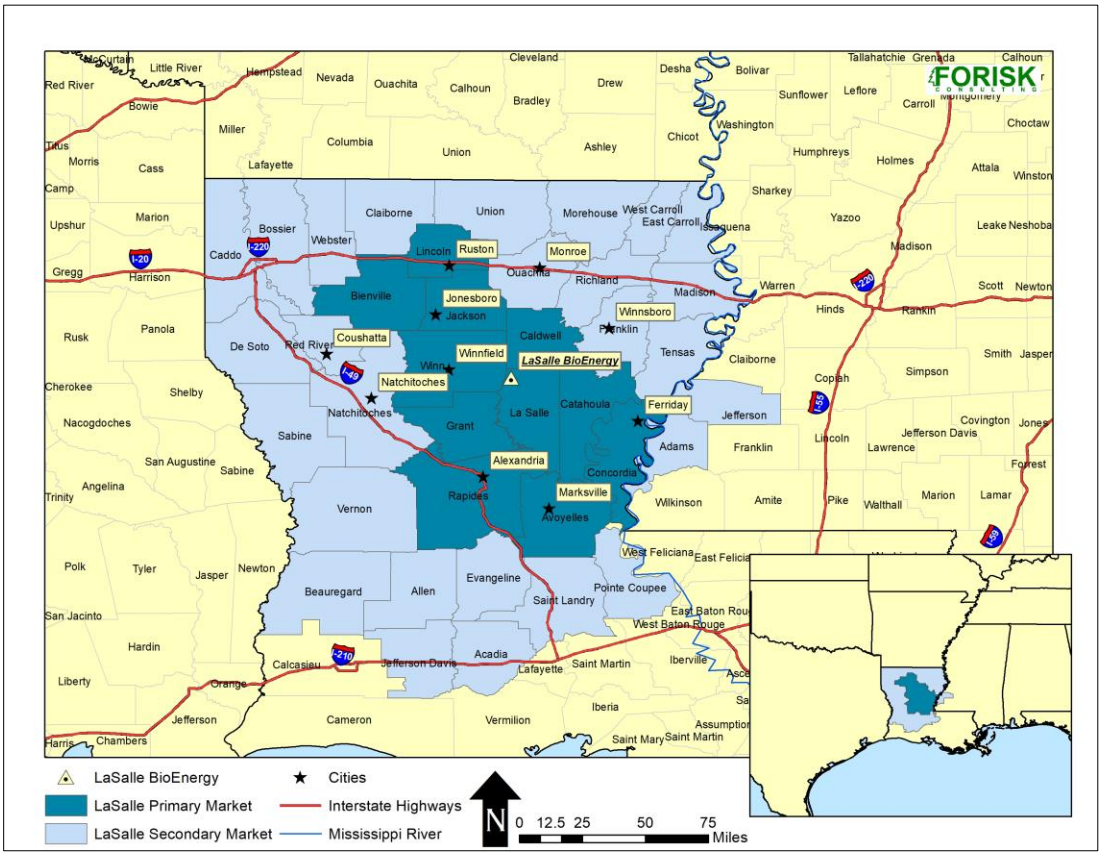
Forest Metric	Bioenergy Impact
Growing Stock	Neutral
Growth Rates	Neutral
Forest Area	Neutral
Wood Prices	Neutral
Markets for Solid Wood	Neutral to Positive*

*Access to viable residual markets benefits users of solid wood (i.e. lumber producers).

LaSalle BioEnergy Timber Market Description

Located in southern Louisiana and western Mississippi, the catchment area was defined using historic and possible future supply boundaries based on proximity, forest resource, and competition with other markets. The approximate 100 air-mile radius of this timber market, which includes 36 counties in Louisiana and two counties in Mississippi, was derived by geo-referencing site specific data from Drax's primary feedstock supplies to the LaSalle mill (Figure 3). Forest derived biomass is generally sourced from the primary market while mill residuals are procured from the larger secondary market. The analysis in this report pertains to the entire area (primary and secondary markets), with selected analysis for the primary market.[1]

Figure 3. LaSalle BioEnergy Timber Market



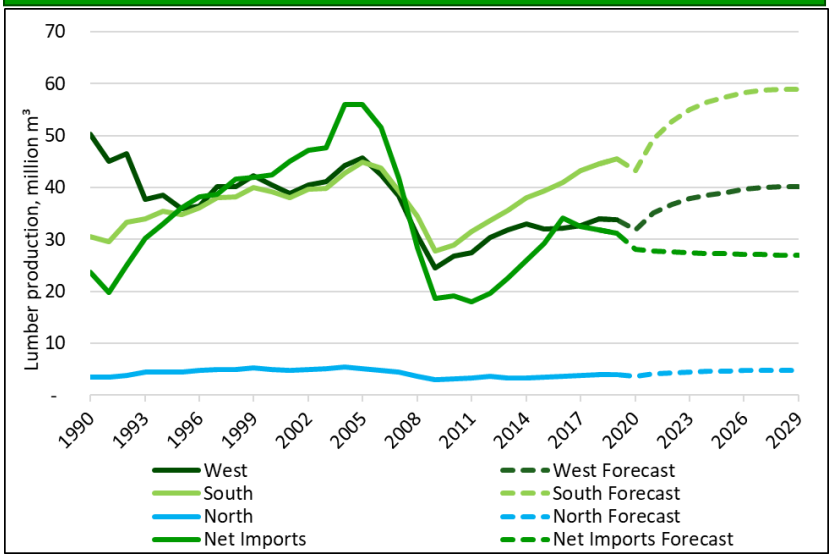
Wood Demand and Markets

The economic Recession in the U.S. from 2007-2009 impacted timber markets across the South and in the LaSalle Market. Conditions today reflect market and timber management activities that responded to the Recession. Sawtimber prices declined 28% on average in the South from 2007-2009, and many landowners deferred final harvests, waiting for prices to recover. The decline in harvest activity and timber removals resulted in sawtimber inventory increases across the South. In the LaSalle Market, sawtimber removals declined 51% from 2005 to 2009, and sawtimber inventories increased 12% from 2008 to 2016.

[1] Unless otherwise noted, the analysis references the combination of primary and secondary markets.

Removals recently increased for both softwood and hardwood sawtimber in the LaSalle Market. This increase is largely driven by local responses to the regional and national trends of (1) improving U.S. housing markets and (2) shifting North American lumber production. The U.S. South exceeded its all-time peak production levels of 45 million m³ for softwood lumber in 2019 while the U.S. West and Canada expect to face timber supply and manufacturing capacity constraints (Figure 4). Softwood lumber capacity continues to shift from the West and Canada to the South. The COVID-19 pandemic slowed lumber production in North America as at least 19% of softwood sawmill capacity curtailed due to lower demand. Some sawmills in western Canada that shuttered due to the coronavirus will likely not reopen given regional timber supply constraints from the mountain pine beetle infestation. The Forisk Base Case lumber forecast projects that U.S. softwood lumber production drops 6% in 2020 and recovers by 2021, with the South leading growth past 2020.

Figure 4. U.S. Softwood Lumber Production Forecast



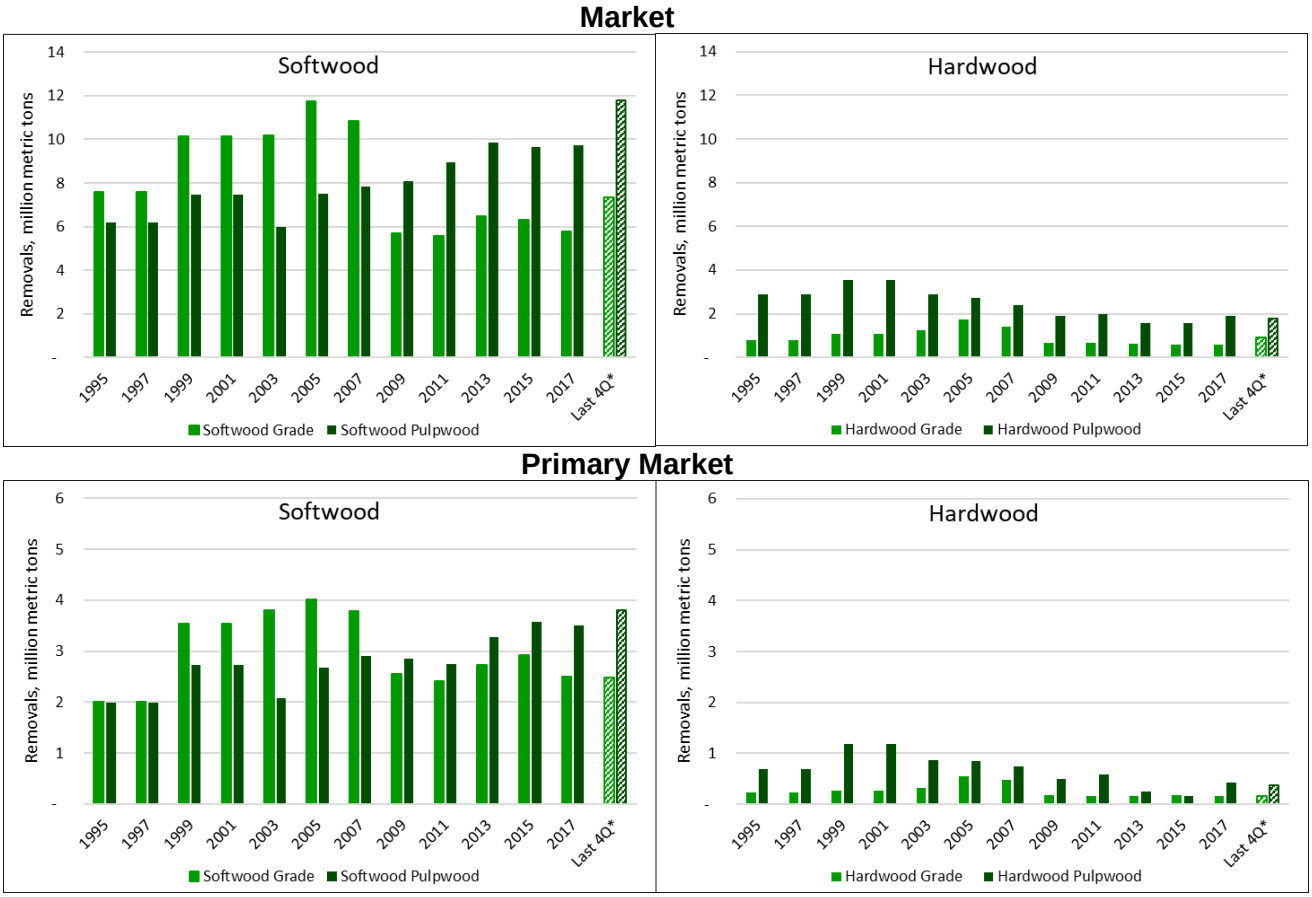
Sources: USDA, WWPA, SFPA, Forisk.
Note: Net imports primarily represent imports from Canada.

Pine sawtimber removals increased in the LaSalle Market by 29% since 2009 (Figure 5). Despite the recent increases in sawtimber removals, the LaSalle Market is still well below 2005 highs. Pine sawtimber removals over the last four quarters were 38% below 2005 volumes while softwood pulpwood removals increased 96% since 2003. Although sawmills have expanded and increased production in the LaSalle Market since the Recession, production in this market has not increased at the same pace as in other local markets across the South. Hardwood sawtimber removals increased 40% since 2009, but are below 2005 highs. Pine pulpwood removals increased 20% from 2009 to 2017 according to U.S. Forest Service data. Data estimated by Forisk for the last four quarters indicates an increase of 49% since 2009 for pine pulpwood removals. Some of the difference in the estimates could be due to different assumptions for procurement activity in the market from the U.S. Forest Service dataset (2017) and the Forisk dataset (last 4Q). In addition, several pulpwood-users in and around the market increased pulpwood use since 2017: Corrigan OSB in Texas opened; Norbord OSB facilities in Texas expanded; German Pellets in Woodville, Texas, reopened; and Drax pellet facilities at Amite, Morehouse, and LaSalle opened or increased capacity. Hardwood pulpwood removals trended down and decreased 5% since 2009. With increased sawtimber production, residues have been more available and are increasingly a target feedstock for pellet plants in the market.

Drax has increased its use of sawmill residuals in the area at the Morehouse plant, and the company is shifting heavily to residual feedstocks at the LaSalle BioEnergy plant.

Removal trends in the primary market generally mirror those of the extended market for pine and hardwood pulpwood (Figure 5). The pine pulpwood increase through the last four quarters (33% since 2009) is lower than in the secondary market; most of the facilities with increases (in Texas) are located to the west of the primary market. Pine grade demand in the primary market has been flat since 2017. This could be due, in part, to different assumptions for procurement activity in the smaller market from the U.S. Forest Service dataset (2017) and the Forisk dataset (last 4Q). In addition, hardwood grade demand declined 9% in the primary market since 2009 while hardwood grade demand increased in the larger market area.

Figure 5. Historic Roundwood Removals



Source: Forisk Consulting, USFS TPO

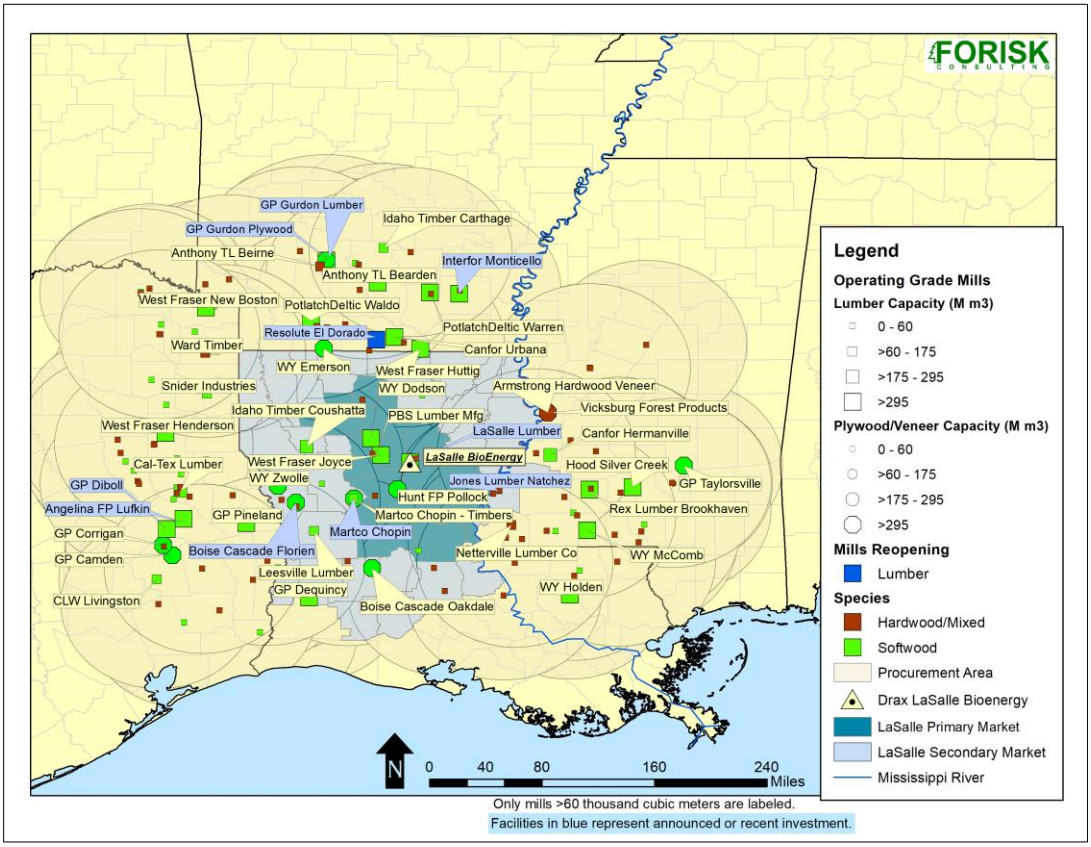
Sawtimber Markets

There are 119 sawmills and 8 plywood mills in or near the Lasalle Market (Figures 6a and 6b). After accounting for the specific locations of the mills and associated procurement activity, the grade wood demand for the LaSalle Market is approximately 8 million metric tons per year, of which softwood demand is 7 million metric tons. Of the sawmills that operate in the LaSalle Market area, 28 sawmills have capacities exceeding 60 thousand m³ of annual lumber production (listed in Appendix A).

Sawtimber demand in the LaSalle Market is projected to increase by 3% by 2023 due to capital investments. Firms announced an additional 1,770 thousand m³ of lumber and plywood capacity in or near the market. Accounting for procurement activity, these investments will add 209K metric tons of sawtimber demand to the market by 2023. Mill announcements include the following:

- Resolute Forest Products acquired Conifex El Dorado in Q1 2020 for an estimated $56 million, then announced $20 million in capital improvements to open the mill by 2021.
- Angelina Forest Products opened a new $100 million softwood sawmill in Q4 2019, with an estimated capacity of 518 thousand m³.
- Boise Cascade Florien will increase green veneer production by 79 thousand m³ in Q2 2020.
- Martco Chopin increased plywood capacity by 40 thousand m³ and installed a new kiln in Q4 2019 for $8 million.
- Interfor Monticello expanded production in Q2 2019 by 165 thousand m³ with a $50 million investment.
- Hunt FP/Tolko opened LaSalle Lumber, a $115 million, 471 thousand m³ sawmill, in 2018. The mill was at full production by end of Q1 2019.
- Jones Lumber invested $18 million to expand grade capacity at the former Rives and Reynolds sawmill in Natchez, MS. The project was scheduled to be finished in Q1 2020.
- Georgia-Pacific plans to invest $70 million into Gurdon lumber and plywood facilities by Q4 2020.

Figure 6a. Map of Sawtimber Log Mills Near LaSalle Market



Note: “grade” refers to sawtimber.

Figure 6b. Operating Sawtimber-Using Facilities Near LaSalle Timber Market

Type	Number of Mills	Capacity	Capacity Units	Consumption, million green metric tons			
				Hardwood Roundwood		Softwood Roundwood	
				At Mill	From Market	At Mill	From Market
Lumber	119	12,266	M m³	2.6	0.8	15.3	5.2
Plywood/Veneer	8	3,362	M m³	0.3	0.1	3.1	1.9
Total	127			2.9	0.9	18.4	7.1

Note: "At mill" sums the total wood consumption for all mills in and near the market. "From market" refers to the amount of wood that mills purchase from the counties within the primary and secondary markets (it accounts for wood procurement activity).

Pulpwood Markets

The LaSalle Market has 47 relevant pulpwood-using mills: 13 pulp/paper mills, 10 OSB/panel plants, 19 chip mills, four pellet facilities, and one electricity plant (Figures 7a & 7b). Accounting for mill location and procurement activity, pulpwood roundwood demand is estimated to be 13.3 million metric tons for the LaSalle Market. Softwood demand accounts for 88% of the estimate (11.7 million metric tons). This market is one of the largest pulpwood markets in the U.S. South. According to Forisk data, Louisiana ranks number two in the South for pine pulpwood demand. Appendix B lists the primary pulpwood-using facilities relevant to the market. Capital expenditures and disinvestments for pulpwood-using mills tend to follow the strength of their given sectors and end-product markets. Important announcements are as follows:

- WestRock Hodge announced plans to improve their Louisiana mill to keep it operating and competitive. The investment was secured by an incentive package from the state and is expected to be completed by the end of 2022.
- Drax announced capacity expansions that total 350K metric tons with an investment of £50 million at Morehouse, Amite, and LaSalle mills.
- Martco OSB plans to invest $23 million at its mill in Oakdale, LA, installing two cyclones on a dryer line and a new rotary drum dyer by Q2 2021.
- Georgia-Pacific permanently closed its pulp mill and bleached board operations in Crossett, AR, in October 2019. Tissue production will continue. The company announced in Q1 2020 that it will invest $37 million into infrastructure, information technology, and production line improvements for tissue and towel lines.
- Graphic Packaging West Monroe announced that effective June 30, 2020, it will close its PM#1 containerboard machine. This follows an announced $120 million investment in its paperboard mill over the next several years, including the installation of two headboxes on PM#6.
- Georgia-Pacific closed its Hope, AR, particleboard facility in Q3 2019.
- Graanul Invest—through its subsidiary Woodville Pellets, LLC—had the winning bid for bankrupt German Pellets Texas in Q2 2019. The sales price was $64.7 million.
- Georgia-Pacific closed its Port Hudson pulp mill in Q1 2019 but will retain its consumer tissue facilities at the location.

Figure 7a. Map of Pulpwood-Using Mills Near LaSalle Timber Market

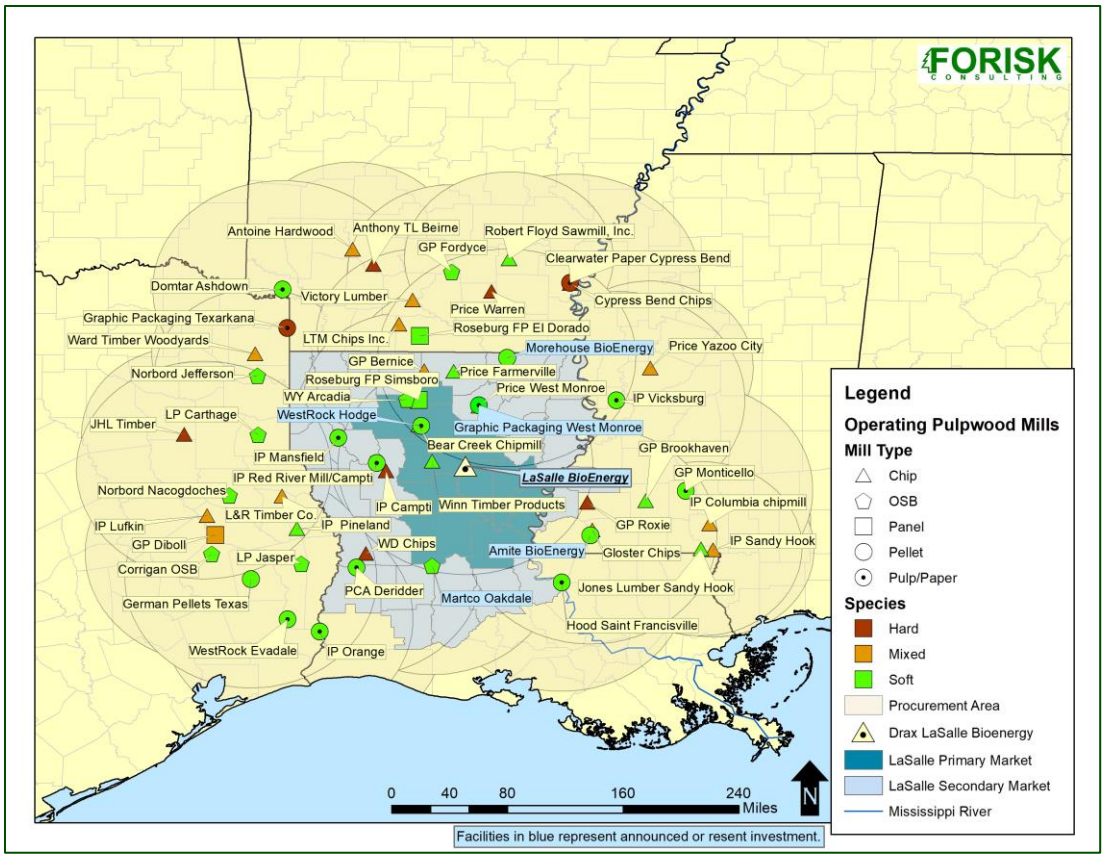


Figure 7b. Operating Pulpwood-Using Facilities Near LaSalle Timber Market

Type	Number of Mills	Capacity	Capacity Units	Consumption, million green metric tons			
				Hardwood Roundwood		Softwood Roundwood	
				At Mill	From Market	At Mill	From Market
Pulp/Paper	13	10,222	M metric tons	2.0	0.6	12.9	5.0
OSB/Panel	10	5,644	M m³	0.0	0.0	6.7	2.3
Chips	19	9,202	M metric tons	3.3	1.0	5.9	3.2
Pellet	4	1,999	M metric tons	0.0	0.0	2.7	1.3
Electricity	1	115	MW	0.0	0.0	0.0	0.0
Total	47			5.3	1.6	28.3	11.7

Note: “At mill” sums the total wood consumption for all mills in and near the market. “From market” refers to the amount of wood that mills purchase from the counties within the primary and secondary markets (it accounts for wood procurement activity).
Note: Capacity is reported as total mill output, but the wood use reported in the table is roundwood (logs) only and excludes other wood supplies, such as chips/sawmill residuals.

Pellet producers use 5.8% of the roundwood used by the forest products industry in the LaSalle Market while LaSalle BioEnergy uses 3.2% of the roundwood in the market (Figure 8). Roundwood pulpwood consumption is concentrated in the pulp and paper sector, which represents 74% of this demand. International Paper is the largest pulpwood consumer in the market (Figure 9).

Figure 8. Roundwood Demand in Market by Sector

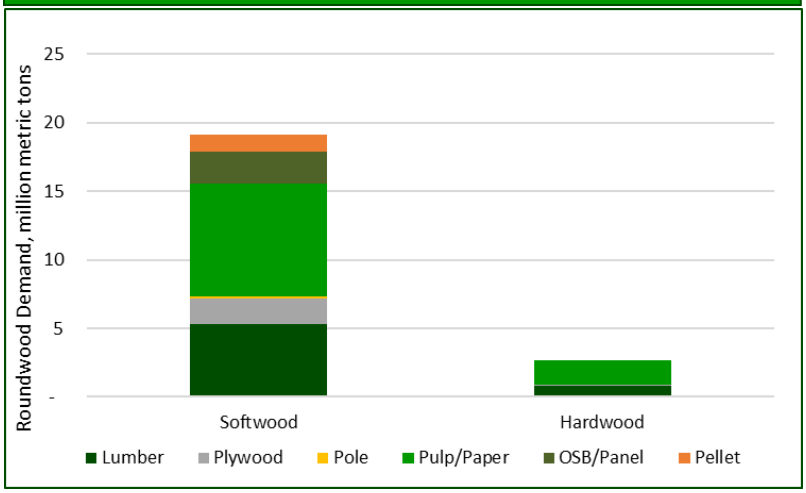
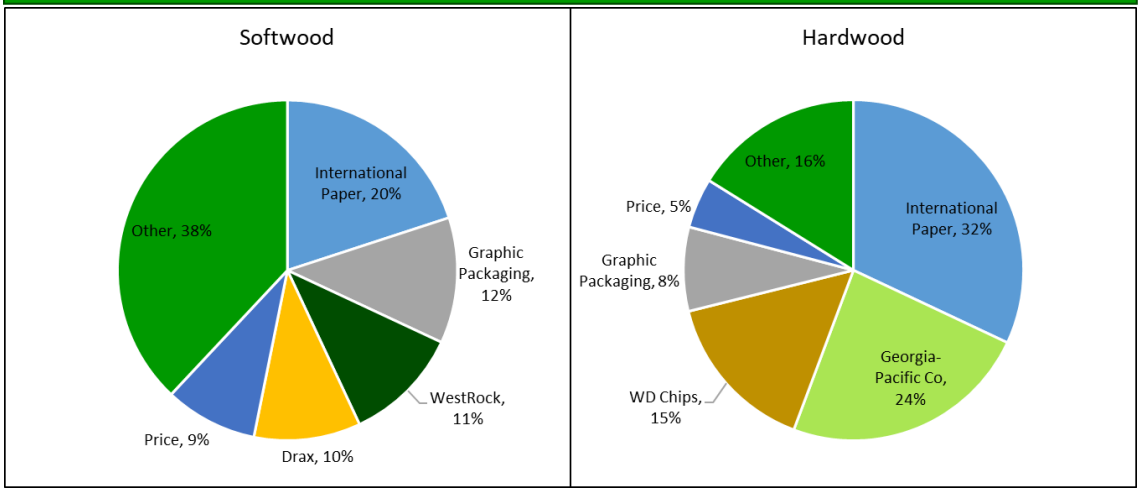


Figure 9. Pulpwood Demand in the Market by Company

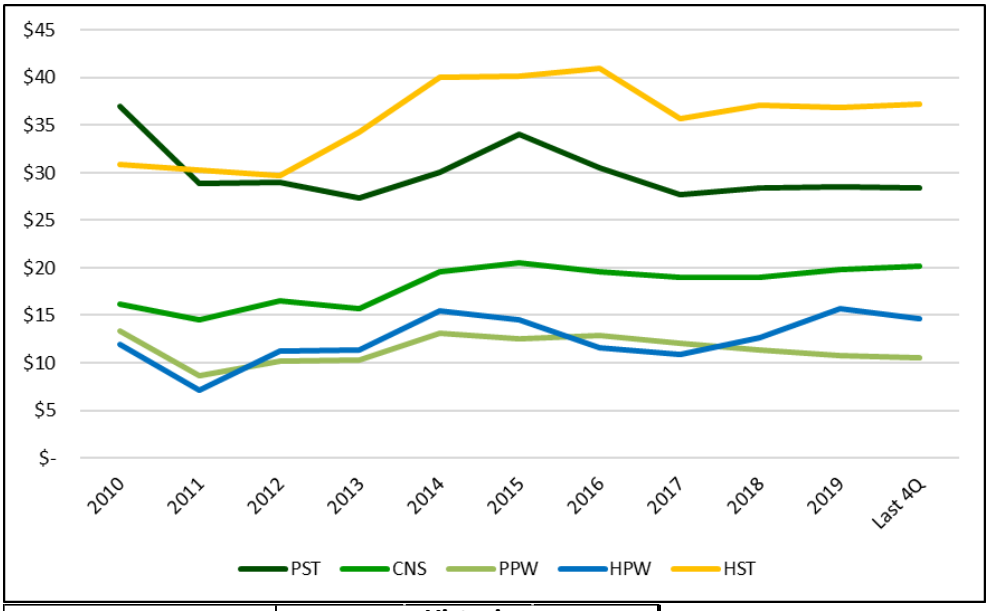


Note: percentages for Georgia-Pacific will decrease with the closure of the Crossett mill.

Timber Prices

Stumpage prices for pine sawtimber and pine pulpwood have declined since 2010 (Figure 10). Only chip-n-saw prices have increased over the period, rising 25% since 2010, with pine sawtimber and pulpwood declining 23% and 22%, respectively. Increasing pine supplies have dampened pricing for pulpwood and sawtimber. In contrast, the supply of hardwood has tightened, contributing to an increase in hardwood sawtimber and hardwood pulpwood pricing. Last 4Q hardwood sawtimber was 22% higher than in 2010, and hardwood pulpwood was 20% higher.

Figure 10. LaSalle BioEnergy Market Historic Stumpage Prices, $/metric ton



Product	Historic		
	Last 4Q	10 yr High	10 yr Low
Pine Sawtimber	$28.35	$37.03	$27.29
Pine Chip-n-Saw	$20.18	$20.49	$14.52
Pine Pulpwood	$10.47	$13.37	$8.69
Hardwood Sawtimber	$37.18	$40.98	$29.72
Hardwood Pulpwood	$14.63	$15.66	$7.10

Source: Timber Mart-South

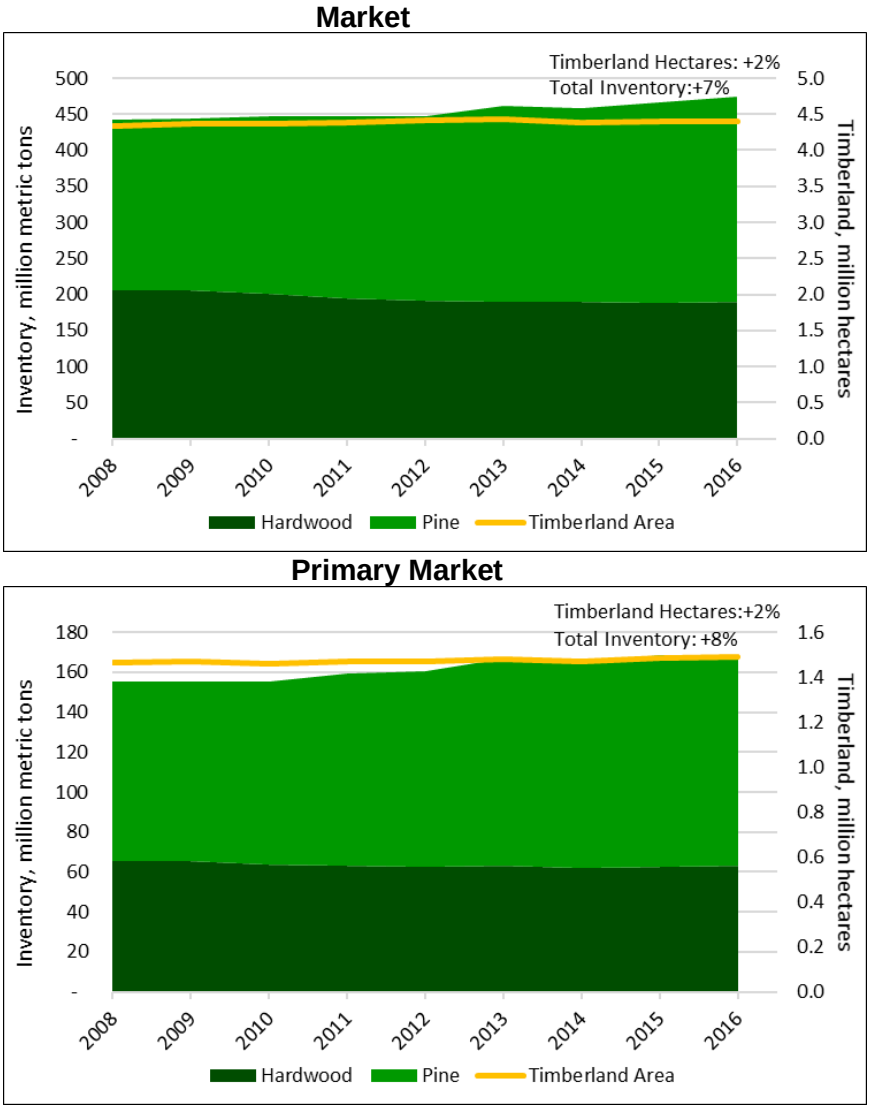
Forest Supply

The LaSalle Market has over 474 million metric tons of merchantable standing timber on 4.4 million hectares of operable timberland.[2] Inventory increased 7.4% since 2008 (Figure 11). Pine inventory volumes increased 21% while hardwood inventory declined 8.0%. Operable timberland hectares in the market increased 1.6% over this time horizon. The increase in inventory over the past ten years is an echo of the economic Recession. Landowners deferred final harvests of sawtimber due to low prices, so timber kept growing on the stump.

The primary market mirrors the extended market. Inventory increased 8.1% since 2008, with pine volumes rising 17% and hardwood inventory declining 3.9%. Operable timberland gained 1.7% since 2008.

[2] Operable timberland excludes hydric sites and slopes greater than 45%. Merchantable timber is defined as 15 cm – 61 cm (6”–24”) DBH classes. The 2016 estimate, which is the most recent, includes data measured in 2016, 2015, 2014, 2013, and 2012; this represents an “average” 2014 forest. Chart labels correspond to the most recent measurement. Unless otherwise noted, supply data in this report represents public and private owners combined.

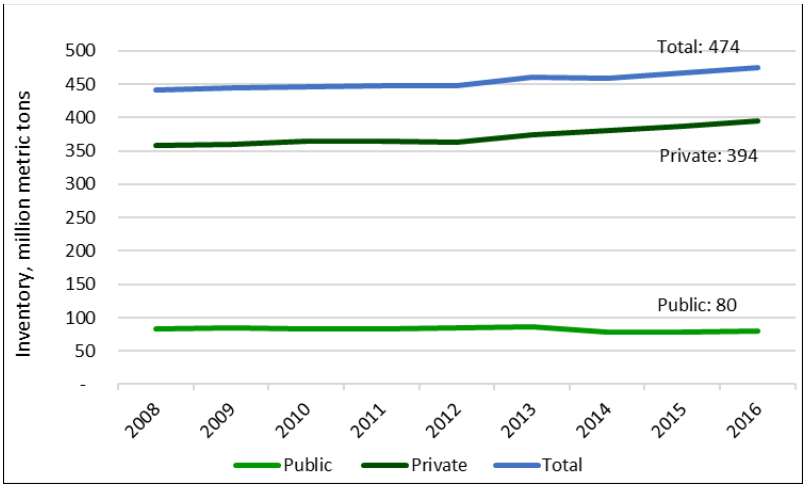
Figure 11. Historic Inventory and Timberland Area



Source: US Forest Service

The majority, 83%, of merchantable standing timber in the LaSalle Market is privately owned (Figure 12). Standing timber on private land increased 10% since 2008, adding 36 million metric tons of inventory. Inventory on public land decreased by 3.4 million metric tons (-4.1%).

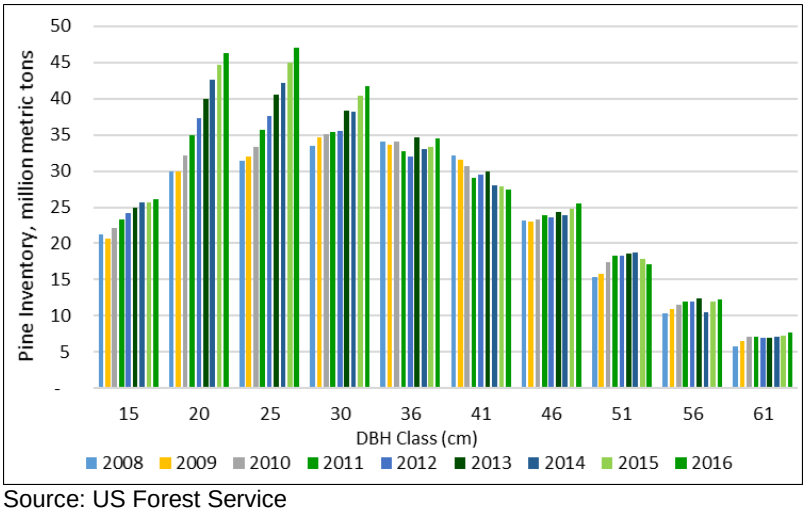
Figure 12. Historic Inventory by Ownership Type



Source: US Forest Service

Pine inventory increased for all size classes in the LaSalle Market since 2008, except the 41 cm DBH class (Figure 13). Most of the volume increase was in the 15 through 30 cm classes, which cumulatively increased 39%.

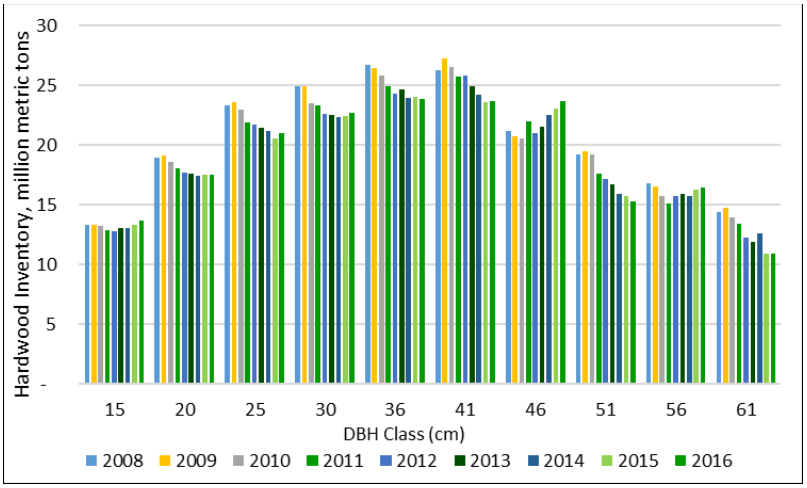
Figure 13. Historic Pine Inventory by DBH Class



Source: US Forest Service

Hardwood inventory declined in most DBH size classes since 2008, with the exception of 15 and 46 cm classes, which increased (Figure 14).

Figure 14. Historic Hardwood Inventory by DBH Class

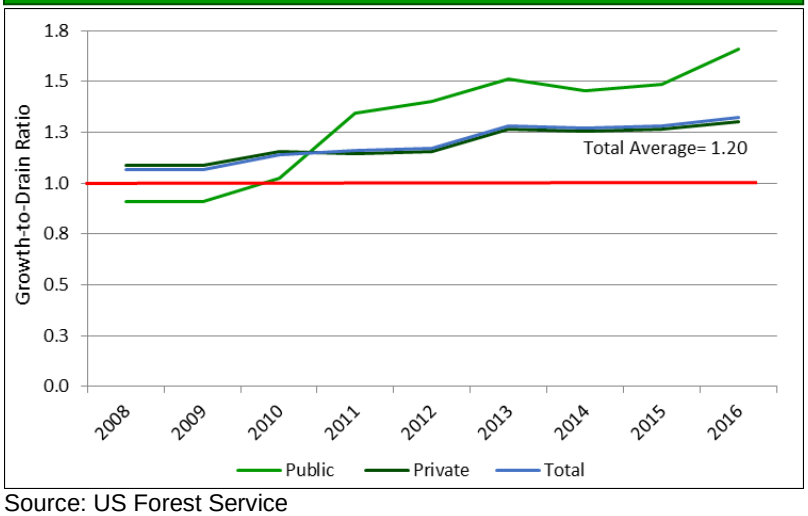


Source: US Forest Service

Since 2008, growth-to-drain (GTD) ratios remained above one, averaging 1.20, with total growth exceeding removals (Figure 15). In 2016, the GTD was 1.32, with the GTD on public land exceeding that on private. Net growth, growth minus removals, has averaged 3.9 million metric tons annually and increased 273% since 2008, surpassing 6.2 million metric tons in 2016 (see Appendix C for additional detail).

The product-specific GTD ratios are in Appendix C. Pine growth outpaced removals in all products since 2010. Pine GTD is currently 1.34. The positive GTD ratios for pine products match the growing accumulation of pine inventories. Meanwhile, the hardwood GTD ratio also trended higher and is currently 1.27; inventory volumes declined modestly while hardwood removals declined sharply.

Figure 15. Growth-to-Drain Ratio by Owner Type



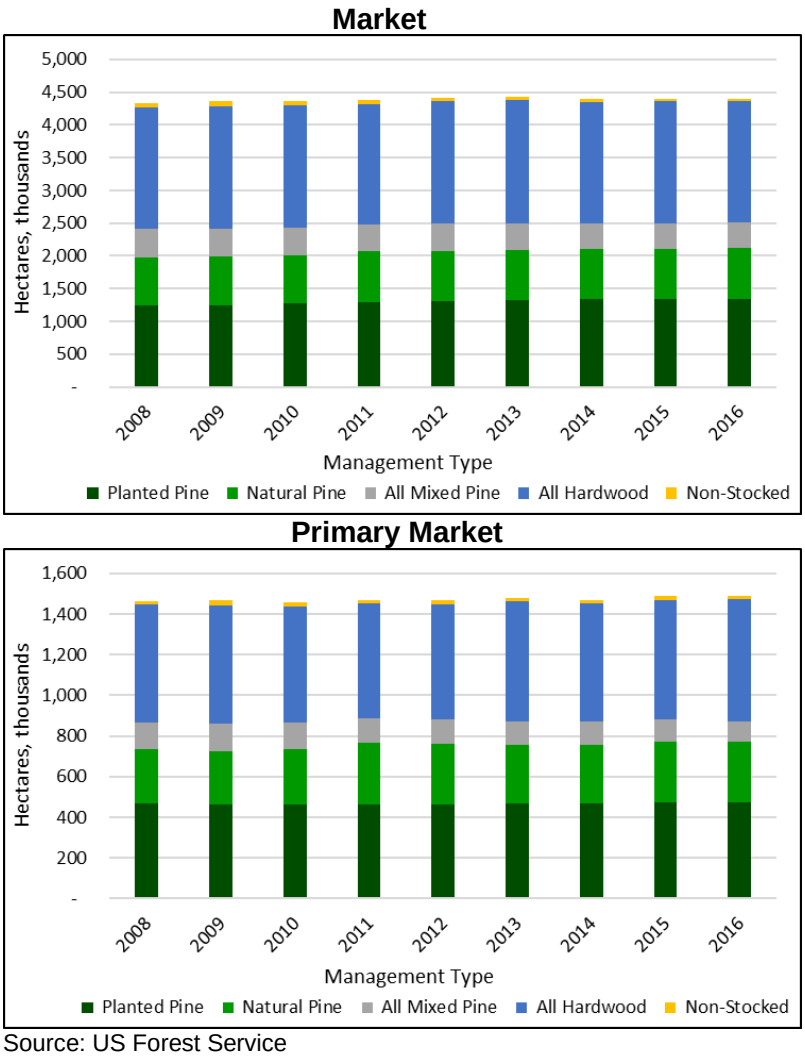
Source: US Forest Service

Timberland area in the LaSalle Market increased by 1.6% since 2008 (Figure 16). Trends of forest type change in the market mirror South-wide increases in pine plantation hectares. Hectares in planted pine increased by 8.7% in the LaSalle Market, the most of any timber

management type. Natural pine and hardwood hectares also increased, gaining 4.8% and 0.4%, respectively. Timberland hectares of mixed pine stands declined 11%. Landowners in the market and in the Southern U.S. plant trees to reforest timberland. These trends indicate conversion of mixed pine hectares to planted pine. Despite some conversion, mixed stands still make up 8.8% of timberland hectares in the LaSalle Market today, down from 10% in 2008.

Within the primary market, mixed pine hectares were also converted but largely to natural pine stands and hardwood stands, which increased in area by 12% and 3.7%, respectively. Hectares of planted pine also increased though only by 1.1%. Overall, the primary market saw timberland area increase 1.7%.

Figure 16. Timberland Area by Management Type

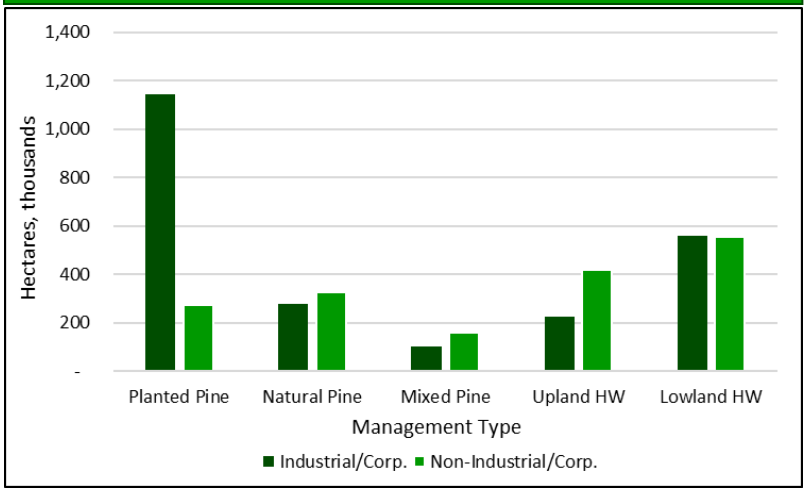


Source: US Forest Service

The market has a high proportion of corporate timberland ownership; 57% of private timberlands in the LaSalle Market are owned by corporate owners (i.e. TIMOs, REITs, corporations). These owners are driven by cash flow expectations, which influences their harvesting and replanting activity, more so than non-industrial owners. They are more active managers of timber, in general, than non-industrial owners. Corporate owners represent 81% of the over 1.4 million

hectares of privately-owned planted pine in the market and only 46% of the 600 thousand hectares of natural pine stands (Figure 17).

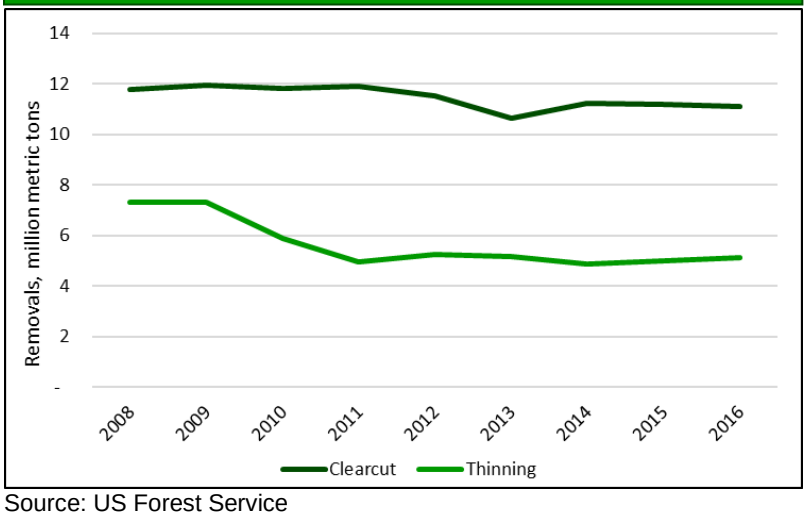
Figure 17. Current Private Timberland Area by Ownership and Management Type



Source: US Forest Service, SOFAC

Removals through clearcuts trended down following the Recession as landowners held off final harvests due to lower sawtimber prices (Figure 18). Volumes have increased but not recovered. Clearcut removals in 2016 were 5.7% lower than in 2008. Since 2013, as markets recovered and landowners accepted market prices for timber, clearcuts increased 4.2%. In 2016, removals from thinnings were down 30% from 2008 levels. Clearcuts represent the majority of volume removed, 68% in 2016.

Figure 18. Historic Removals by Harvest Type



Source: US Forest Service

Forest Management

Silviculture Survey

Our best understanding of forest management intensity in the region derives from Forisk's Southern Silviculture Surveys in 2016, 2018, and 2020, which assessed the practices of large

landowners and managers (4,047+ hectares). These surveys captured data on 7, 10, and 11 million hectares, respectively. The surveys examined different geographic sub-regions, with the Drax market captured in two different sub-regions across the three surveys. In 2016, the "Gulf" region included Arkansas, Louisiana, Texas, and Mississippi. The surveys in 2018 and 2020 examined the Upper Coastal Plain, which stretches from Texas to Virginia, and includes significant areas in both Alabama and Georgia, with smaller coverage in the Carolinas and Virginia (Figure 19 and 20).

Figure 19. 2016 Survey Regions

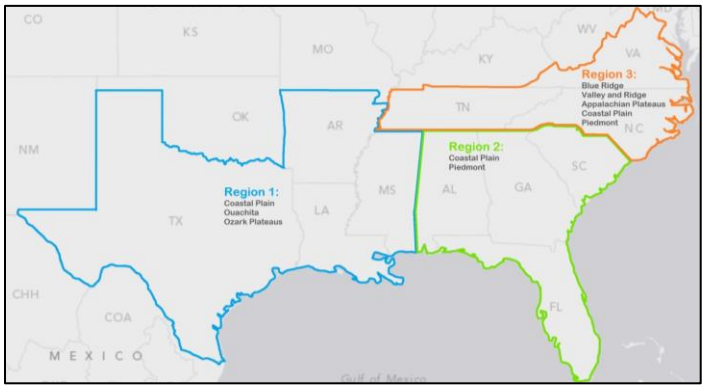
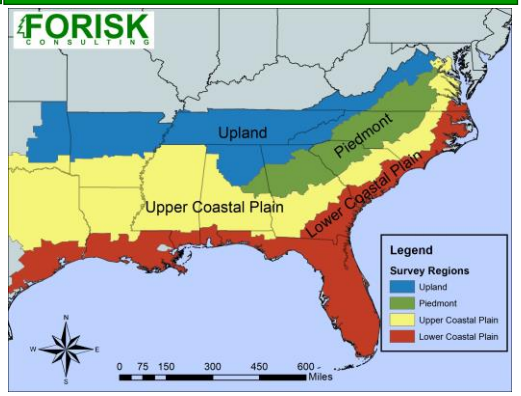


Figure 20. 2018 Survey Regions



Despite the differing regions, the management intensity is reasonably consistent. Advanced genetic seedlings were used on less than half of regenerated areas in the target market compared with 55-65% in other regions (Figure 21). Seedling survival in 2018 and 2020 was on par with the South-wide average but was 5% lower in the 2016 survey. In 2020, the region employed less mid-rotation woody competition control than the other regions of the South for the first time in our research. Fertilization is utilized relatively frequently in the market, with 61% of firms reporting use. Hectares receive nearly 2 applications per rotation on average. Finally, clearcut ages are the highest in the South. In 2016, the Gulf region clearcut age averaged 36 years with the lowest net revenue per acre of any region. The Upper Coastal Plain averaged 30 years as an average clearcut age, also highest in the South. The Upper Coastal Plain reported the highest proportion of hectares managed on a 2-thinning regime, 43% compared to 35% across the other regions. Respondents in 2020 reported hectares in the Upper Coastal Plain averaged 13 metric tons per hectare per year growth, higher than any other region in the South.

Figure 21. Silviculture Practices by Region

	2016		2018		2020	
	Gulf Region	South	Upper Coastal Plain	South	Upper Coastal Plain	South
Advanced Genetic Stock (% hectacres)	46%	65%	49%	56%	43%	54%
Seedling Survival	85%	90%	89%	89%	88%	88%
Woody Competition Control*	5%	4%	58%	45%	60%	68%
Fertilization (% respondents)	57%	55%	58%	60%	61%	61%
Clearcut age	36	32	30	28	31	28
Avg. Clearcut Revenue	$3,744	$3,988	$3,776	$3,862	$4,008	$4,228

*Survey question changed from 2016 to 2018 from total % hectares treated in a given year to total % receiving treatment in a rotation.
Source: Forisk Consulting

In summary, managers in the LaSalle Market region have planted advanced seedlings less frequently than other regions of the South. Reasonably intense hardwood competition control is required and utilized. Fertilization is fairly aggressively applied. Pine growth rates in the region are the highest reported in the South. Reported clearcut ages are older than in other regions, yet average revenue is not higher. Both are somewhat representative of local markets, but also indicative of the current age profile of the region.

Forest Management Strategies

Based on research and analysis by Forisk and F&W Forestry Services across a range of absolute and relative product prices, forest owners would likely continue to optimize the growth and sale of sawtimber as versions of this approach generate the best returns. The results support previous research that forest owner shifts from sawtimber to pulpwood rotations remains unlikely.

This analysis summarizes previous research and models forest management strategies in the LaSalle catchment area to offer context and test the question, "At what pricing levels would landowners sell sawtimber-sized trees to biomass markets?" To address the question, we:

1) Summarized previous literature and Forisk analysis related to landowner motivations and decision-making related to forest management, and
2) Developed a market level growth and yield model for LaSalle catchment area to test for price levels that might cause landowners to change forest management strategies from a traditional focus on sawtimber to one emphasizing pulpwood.

Summary Review of Forest Landowner Decision Making

Wood procurement professionals, timberland investors and forest economists all care about the ways that landowners make forest management decisions as and when local markets change. These decisions range from "When do owners decide to convert their land to or from forests?" to "How actively do owners manage their forests?" to "How do they decide when to harvest trees?"

Previous research finds that, over time and through economic cycles, timber markets gradually achieve or return to market equilibriums by adjusting to changes in prices, supplies, rotation ages and harvest levels[3]. Forestland owners consistently make decisions with respect to long-term economics and appear to not feel compelled or obligated to satisfy third-party targets (i.e. for energy production or to sell wood to new bioenergy plants) unless the economics make sense. In a white paper commissioned by NAFO, Clutter et al. (2010), revisited this research to model forest owner behavior in light of evolving bioenergy markets and concluded "…landowner responses clearly increase supply and decrease raw materials costs in the long-run…"[4]

In 2018, Forisk analyzed the financial returns of forest management and implications for timberland investor decisions.[5] Estimating the return on investment and value created from active forest management requires comparing different management strategies in terms of silviculture costs and volume gains by product, and then quantifying this with respect to changes

[3] Brazee and Mendelsohn 1990; Yin and Newman 1999; Prestemon and Holmes 2000.

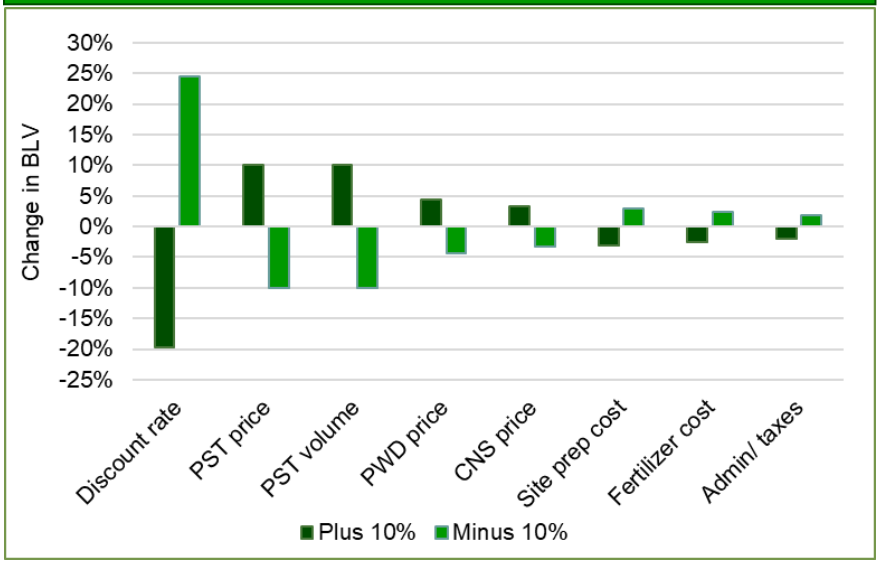
[4] Clutter, M., R. Abt, D. Greene, and J. Siry. 2010. A developing bioenergy market and its implications on forests and forest products markets in the United States: economic considerations. *National Alliance of Forest Owners White Paper*. April: 1-10. Available at: http://nafoalliance.org/clutter/

[5] Forisk Facts & Figures: how sensitive are forestland values to changes in reforestation costs, timber prices and management intensity. *Q1 2018 Forisk Research Quarterly (FRQ*)

in bare land value (BLV) which facilitates an economic "apples-to-apples" comparison. BLV is a version of net present value (NPV) that assumes an infinite series of cash flows on a property with prices and harvest volumes that are the same for every harvest rotation in perpetuity.

On the margin, active forest management consistently and materially outperforms passive forest management in biologic and economic returns. The sensitivity analysis in Figure 22 reinforces that greater forest values associated with intensive management are robust against higher silviculture costs. Higher sensitivities to assumed discount rates, estimated growth and yields of sawtimber volumes, and forecasted sawtimber prices highlight the dependence of timberland returns on the local markets for wood, assumptions related to future stumpage prices, and the ability to implement site-appropriate forest management plans.

Figure 22. Sensitivity Analysis of Bare Land Value



Notes: analysis used +/- 10% for key inputs associated with active forest management to estimate value changes to the bare land.
Source: *Q1 2018 Forisk Research Quarterly (FRQ)*

Forest Management Analysis for the LaSalle Catchment

Forisk contracted with F&W Forestry to model the growth and yield results and forest management implications associated with different pricing for the LaSalle, LA, market.[6] We tested how different price levels might cause landowners to change management strategies from a sawtimber rotation to a pulpwood rotation. See Appendix D for a description of model assumptions.

The modeling applied four different pricing scenarios for pulpwood (PPW), chip-n-saw (CNS), and pine sawtimber (PST) to evaluate economically optimal landowner management strategies and used a real discount rate of 5.0% (Figure 23).

[6] F&W Forestry is an international forest resource management and consulting firm dedicated to helping landowners gain the most value and enjoyment per acre from their land.

Figure 23. Product Pricing Scenarios ($/metric ton) Costs

Product	Scenario 1 (Avg Last 4Q)	Scenario 2 (Avg Last 10 yr)	Scenario 3 (1stQ-2016)*	Scenario 4 (Pulp = 66% of 10yr Avg Saw)
Pine Pulpwood	$10.25	$11.17	$14.02	$20.22
Pine Chip-n-saw	$20.01	$18.09	$19.24	$20.22
Pine Large Sawtimber	$28.49	$30.34	$29.91	$30.34
Sawtimber / Pulpwood	2.8	2.7	2.1	1.5

*lowest sawtimber-to-pulpwood ratio recorded
Note: pricing based on Timber Mart-South data from LA-1, LA-2, and MS-2 regions.

Results of the analysis indicate minimal difference in optimal forest management strategies across the four scenarios. Figure 24 summarizes the average harvest ages under all scenarios that maximize economic returns. This implies that, for a range of absolute and relative product prices and a 5.0% discount rate, forest owners would continue to optimize the growth sawtimber as versions of this approach generate the best returns.

Figure 24. Average Harvest Ages of First Four Rotations

Harvest Operation	Scenario 1	Scenario 2	Scenario 3	Scenario 4
First Thin	14.25	15	15	15
Second Thin	24.25	24.25	24.25	23.5
Final Harvest	32	32	32	31

Source: F&W Forestry Services

This result was surprising given the difference in the ratios between sawtimber and pulpwood. Typically, as the gap between pulpwood and sawtimber closes there is less incentive for multiple thinnings and longer rotations to produce higher value larger trees. However, given the current market discount rate of 5.0%, the two thin regime with final harvest around age 30 is still the optimal management scenario even with a 1.5:1 sawtimber to pulpwood price ratio.

Tests were conducted to verify the functionality of the optimization model. The discount rate was increased to 9%, and Scenario 4 was modified to where all three products were valued at $20.22/metric ton. The results of this test verified that the model functioned as expected in that harvest ages changed as expected. Results of this test are in Figure 25.

Figure 25. Average Harvest Ages of First Four Rotations, Model Test

Harvest Operation	Scenario 1	Scenario 2	Scenario 3	Modified Scenario 4*
First Thin	11	11.25	12	12
Second Thin	18	16.25	17	N/A
Final Harvest	25.5	25.5	24	17

Source: F&W Forestry Services
*Sawtimber price = pulpwood price

As expected, the higher discount rate led to materially shorter forest rotations as it raises the opportunity costs associated with growing trees longer. Also, the results of the verification test show that a significant change in the market discount rate must also be accompanied by a narrowing of the gap between sawtimber and pulpwood prices to shift the management to pulpwood rotations. One additional result is that with all scenarios tested at least one thinning was included in every optimal management regime. The decision point to manage as pulpwood and restart the stand can be delayed until ages 17- 20, thus providing flexibility in management.

As 50% of pine sawtimber ends up as residual chips for pulpwood consumers, a complementary relationship exists. Therefore, the existence of well capitalized pine sawtimber markets ensures a steady demand of mature logs, from a volume standpoint, which leaves chip-n-saw and pulpwood to adjust their respective specifications as demand for pulpwood increases or decreases.

The analysis supports previous research that forest owner shifts from sawtimber to pulpwood rotations remains unlikely. It is important to keep the assumptions of the analysis in mind when applying the results. The methodology used here to compare management regimes and price levels is a conservative approach that assumes price inputs will remain constant in perpetuity. Certainly, prices in the marketplace fluctuate over time. Forestry is a long-term business, and landowners avoid sweeping changes in their strategies until new pricing regimes are proven.

Appendix A: Grade Mill List

LaSalle BioEnergy Timberland Market Grade-Using Facilities Greater Than 60 M m³

Name	County	State	Type	Capacity	Capacity Units	Total Wood Consumption (green metric tons)	Softwood Roundwood Consumption at Capacity (green metric tons)	Hardwood Roundwood Consumption at Capacity (green metric tons)
GP Pineland	Sabine	TX	lumber	729	M m³	1,212,090	1,212,090	-
WY McComb	Pike	MS	lumber	706	M m³	1,172,990	1,172,990	-
PotlatchDeltic Waldo	Columbia	AR	lumber	671	M m³	1,114,341	1,114,341	-
West Fraser Joyce	Winn	LA	lumber	612	M m³	849,125	849,125	-
West Fraser Huttig	Union	AR	lumber	541	M m³	899,292	899,292	-
WY Dodson	Winn	LA	lumber	541	M m³	899,292	899,292	-
Angelina FP Lufkin	Angelina	TX	lumber	518	M m³	758,407	758,407	-
PotlatchDeltic Warren	Bradley	AR	lumber	518	M m³	798,323	798,323	-
GP Dequincy	Calcasieu	LA	lumber	494	M m³	821,093	821,093	-
Anthony TL Bearden	Ouachita	AR	lumber	471	M m³	870,898	870,898	-
LaSalle Lumber	LaSalle	LA	lumber	471	M m³	771,107	771,107	-
West Fraser New Boston	Bowie	TX	lumber	471	M m³	781,993	781,993	-
Canfor Urbana	Union	AR	lumber	447	M m³	742,894	742,894	-
Interfor Monticello	Drew	AR	lumber	424	M m³	685,832	685,832	-
Rex Lumber Brookhaven	Lincoln	MS	lumber	412	M m³	684,244	684,244	-
WY Holden	Livingston	LA	lumber	400	M m³	664,694	664,694	-
Hood Silver Creek	Lawrence	MS	lumber	376	M m³	625,595	625,595	-
West Fraser Henderson	Rusk	TX	lumber	329	M m³	547,395	547,395	-
Cal-Tex Lumber	Nacogdoches	TX	lumber	282	M m³	500,766	500,766	-
Canfor Hermanville	Claiborne	MS	lumber	235	M m³	390,997	390,997	-
Vicksburg Forest Products	Warren	MS	lumber	235	M m³	390,997	390,997	-
Idaho Timber Coushatta	Red River	LA	lumber	224	M m³	396,440	396,440	-
Ward Timber	Cass	TX	lumber	160	M m³	341,102	163,293	177,808
Snider Industries	Harrison	TX	lumber	141	M m³	250,383	250,383	-
Leesville Lumber	Vernon	LA	lumber	118	M m³	208,653	208,653	-
PBS Lumber Mfg	Winn	LA	lumber	82	M m³	158,757	158,757	-
Netterville Lumber Co	Wilkinson	MS	lumber	71	M m³	214,186	-	214,186
Martco Chopin - Timbers	Rapides	LA	lumber	61	M m³	94,347	94,347	-
Martco Chopin	Rapides	LA	plywood/veneer	678	M m³	999,491	999,491	-
GP Gurdon	Clark	AR	plywood/veneer	667	M m³	1,043,716	1,043,716	-
Boise Cascade Florien	Sabine	LA	plywood/veneer	492	M m³	769,520	769,520	-
Boise Cascade Oakdale	Allen	LA	plywood/veneer	441	M m³	689,914	689,914	-
Armstrong Hardwood Veneer	Warren	MS	plywood/veneer	283	M m³	442,253	-	442,253
Hunt FP Pollock	Grant	LA	plywood/veneer	283	M m³	442,253	442,253	-
WY Zwolle	Sabine	LA	plywood/veneer	283	M m³	442,253	442,253	-
WY Emerson	Columbia	AR	plywood/veneer	237	M m³	371,492	371,492	-

Source: Forisk Consulting

Appendix B: Pulpwood Mill List

LaSalle BioEnergy Timberland Market Pulpwood-Using Facilities

Name	County	State	Type	Capacity	Capacity Units	Total Wood Consumption (green metric tons)	Softwood Roundwood Consumption at Capacity (green metric tons)	Hardwood Roundwood Consumption at Capacity (green metric tons)
IP Mansfield	De Soto	LA	pulp/paper	1,651	M metric tons	3,284,010	1,723,652	571,527
GP Monticello	Lawrence	MS	pulp/paper	1,003	M metric tons	2,857,531	771,533	-
PCA Deridder	Beauregard	LA	pulp/paper	980	M metric tons	2,267,164	2,108,463	-
IP Red River Mill/Campti	Natchitoches	LA	pulp/paper	925	M metric tons	1,179,341	816,467	-
Graphic Packaging West Monroe	Ouachita	LA	pulp/paper	862	M metric tons	2,585,477	-	-
IP Orange	Orange	TX	pulp/paper	837	M metric tons	2,104,669	1,723,652	-
WestRock Hodge	Jackson	LA	pulp/paper	815	M metric tons	2,086,526	1,360,778	-
Domtar Ashdown	Little River	AR	pulp/paper	708	M metric tons	3,538,022	2,267,963	-
WestRock Evadale	Jasper	TX	pulp/paper	640	M metric tons	2,540,118	1,360,778	426,377
Graphic Packaging Texarkana	Bowie	TX	pulp/paper	630	M metric tons	2,572,466	1,054,049	887,857
IP Vicksburg	Warren	MS	pulp/paper	544	M metric tons	1,743,972	1,085,623	361,874
Hood Saint Francisville	West Feliciana	LA	pulp/paper	340	M metric tons	848,218	-	-
Clearwater Paper Cypress Bend	Desha	AR	pulp/paper	287	M metric tons	1,088,622	-	-
Corrigan OSB	Polk	TX	OSB	961	M m^3	1,411,126	1,411,126	-
Martco Oakdale	Allen	LA	OSB	961	M m^3	1,411,126	1,411,126	-
GP Fordyce	Dallas	AR	OSB	565	M m^3	830,074	830,074	-
LP Carthage	Panola	TX	OSB	565	M m^3	830,074	830,074	-
Norbord Jefferson	Marion	TX	OSB	565	M m^3	688,962	688,962	-
LP Jasper	Jasper	TX	OSB	537	M m^3	788,571	788,571	-
WY Arcadia	Lincoln	LA	OSB	480	M m^3	705,563	705,563	-
Norbord Nacogdoches	Nacogdoches	TX	OSB	475	M m^3	630,856	630,856	-
Roseburg FP Simsboro	Lincoln	LA	panel	367	M m^3	362,874	136,078	-
Roseburg FP El Dorado	Union	AR	panel	170	M m^3	249,022	83,007	-
Price West Monroe	Union	LA	chip	1,796	M metric tons	1,796,226	1,796,226	-
WD Chips	Vernon	LA	chip	726	M metric tons	725,748	272,156	453,593
Gloster Chips	Amite	MS	chip	699	M metric tons	734,820	734,820	-
Price Farmerville	Union	LA	chip	699	M metric tons	733,459	733,459	-
GP Brookhaven	Lincoln	MS	chip	653	M metric tons	680,389	340,194	340,194
Bear Creek Chipmill	Jackson	LA	chip	635	M metric tons	666,781	666,781	-
Price Warren	Bradley	AR	chip	475	M metric tons	733,459	183,365	550,094
Cypress Bend Chips	Desha	AR	chip	454	M metric tons	453,593	181,437	272,156
IP Columbia chipmill	Marion	MS	chip	454	M metric tons	689,461	453,593	235,868
L&R Timber Co.	San Augustine	TX	chip	408	M metric tons	408,233	181,437	226,796
Price Yazoo City	Yazoo	MS	chip	390	M metric tons	680,389	204,117	476,272
GP Bernice	Union	LA	chip	363	M metric tons	362,874	181,437	181,437
GP Roxie	Franklin	MS	chip	272	M metric tons	285,763	71,441	214,322
IP Campti	Natchitoches	LA	chip	272	M metric tons	272,156	90,719	181,437
LTM Chips Inc.	Union	AR	chip	272	M metric tons	272,156	136,078	136,078
Winn Timber Products	Winn	LA	chip	272	M metric tons	272,156	181,437	90,719
Ward Timber Woodyards	Cass	TX	chip	227	M metric tons	226,796	22,680	204,117
Victory Lumber	Ouachita	AR	chip	136	M metric tons	136,078	68,039	68,039
Amite BioEnergy	Amite	MS	pellet	524	M metric tons	1,153,576	692,146	-
Morehouse BioEnergy	Morehouse	LA	pellet	524	M metric tons	1,153,576	576,788	-
German Pellets Texas	Tyler	TX	pellet	500	M metric tons	1,100,001	715,001	-
LaSalle BioEnergy	La Salle	LA	pellet	450	M metric tons	989,920	692,944	-
BioWood LLC	Drew	AR	pellet	36	M metric tons	79,832	-	-
Patterson Wood Products	Nacogdoches	TX	pellet	18	M metric tons	39,916	-	-
Nacogdoches Generating Plant	Nacogdoches	TX	electricity	115	MW	1,088,622	272,156	-

Source: Forisk Consulting

Appendix C: Supporting Data

LaSalle BioEnergy Timberland Market Historic Inventory by Ownership and Species

Private

	Pine			Hardwood			Total		
Year	Pulpwood	Grade	Total	Pulpwood	Grade	Total	Pulpwood	Grade	Total
	million metric tons								
2008	72	121	193	92	74	166	164	194	358
2009	71	122	193	93	74	167	164	196	360
2010	76	125	201	90	73	163	166	198	364
2011	81	124	205	88	71	160	169	196	364
2012	84	123	208	86	69	155	170	193	363
2013	90	130	220	85	69	154	175	200	374
2014	95	130	226	86	70	155	181	200	381
2015	99	135	233	85	69	154	184	204	388
2016	102	137	239	86	69	155	188	206	394

Public

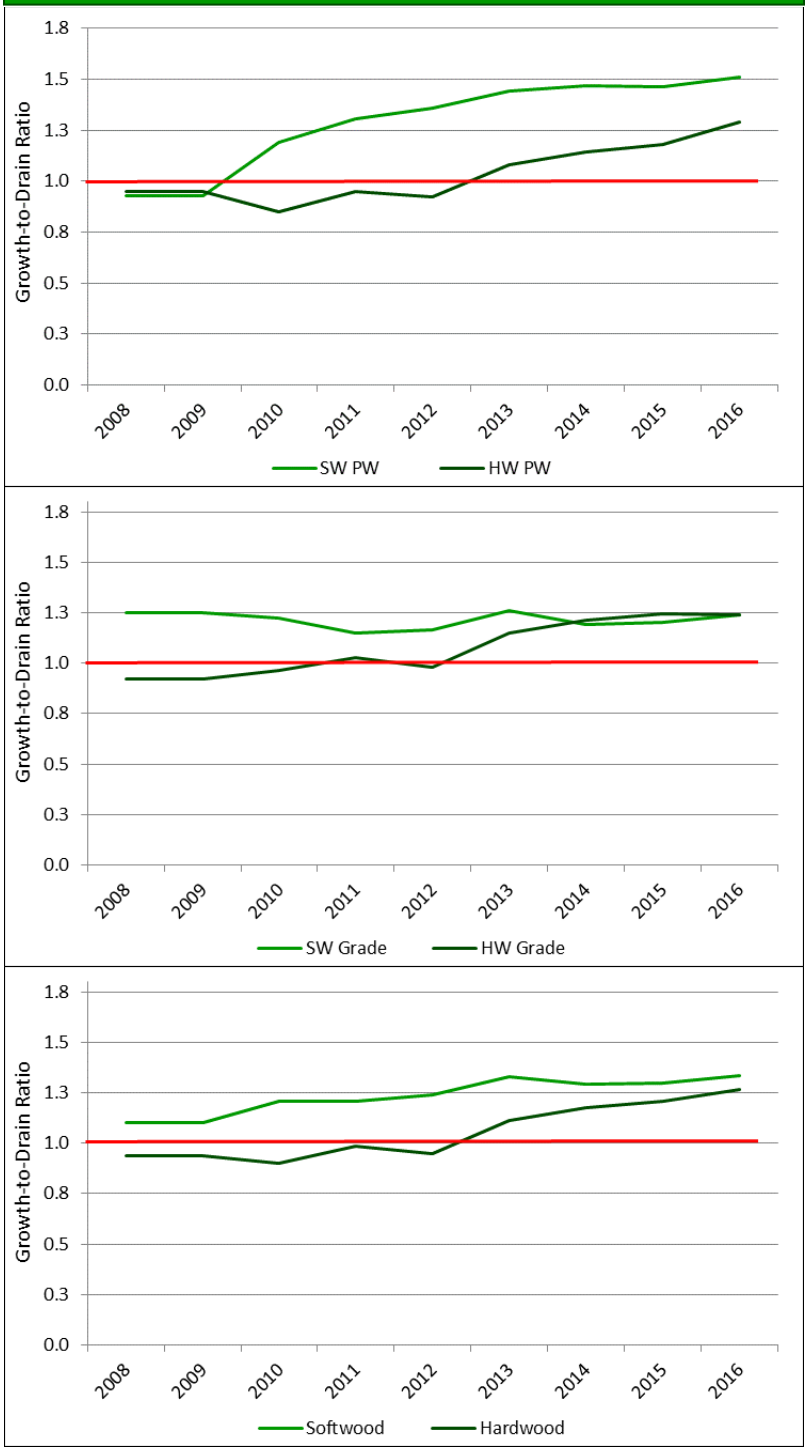
	Pine			Hardwood			Total		
Year	Pulpwood	Grade	Total	Pulpwood	Grade	Total	Pulpwood	Grade	Total
	million metric tons								
2008	10	34	44	20	20	39	30	54	84
2009	11	35	45	20	20	39	30	54	85
2010	11	35	46	19	18	37	29	54	83
2011	11	36	48	18	18	35	29	54	83
2012	12	38	49	18	18	36	30	55	85
2013	12	39	51	18	18	36	30	56	87
2014	10	34	44	17	17	34	27	51	78
2015	10	35	46	17	16	33	28	51	79
2016	10	36	47	18	16	34	28	52	80

Total

	Pine			Hardwood			Total		
Year	Pulpwood	Grade	Total	Pulpwood	Grade	Total	Pulpwood	Grade	Total
	million metric tons								
2008	82	155	237	112	93	205	194	248	442
2009	82	156	239	112	94	206	194	250	445
2010	87	160	247	109	91	200	196	251	447
2011	92	160	252	106	89	195	198	250	447
2012	96	161	257	104	87	191	200	248	448
2013	102	169	271	104	87	190	205	256	461
2014	105	165	270	103	86	189	208	251	459
2015	109	170	279	102	85	188	212	255	466
2016	113	173	286	103	85	189	216	259	475

Source: US Forest Service

Historic Growth-to-Drain by Species and Product



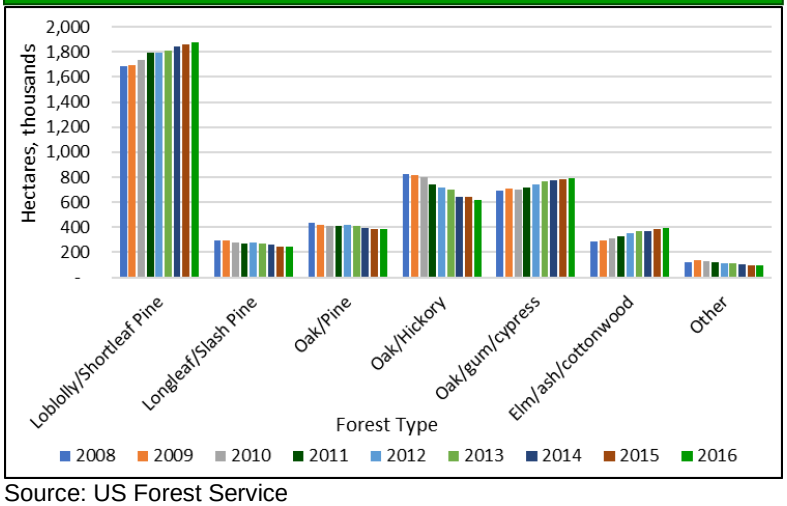
Source: US Forest Service

LaSalle BioEnergy Timberland Market Historic Growth and Removals by Species

Year	Pine				Hardwood			
	Growth	Removals	Net Growth	Growth-to-Drain	Growth	Removals	Net Growth	Growth-to-Drain
	(million metric tons)				(million metric tons)			
2008	21.88	19.87	2.01	1.10	5.19	5.54	-0.34	0.94
2009	21.88	19.87	2.01	1.10	5.19	5.54	-0.34	0.94
2010	20.53	16.97	3.57	1.21	4.48	4.98	-0.50	0.90
2011	19.51	16.14	3.37	1.21	4.35	4.42	-0.07	0.98
2012	19.39	15.64	3.75	1.24	4.38	4.62	-0.24	0.95
2013	19.78	14.86	4.91	1.33	4.80	4.32	0.48	1.11
2014	19.44	15.02	4.42	1.29	4.82	4.10	0.72	1.18
2015	19.66	15.12	4.54	1.30	4.78	3.96	0.82	1.21
2016	20.59	15.39	5.19	1.34	4.82	3.80	1.02	1.27

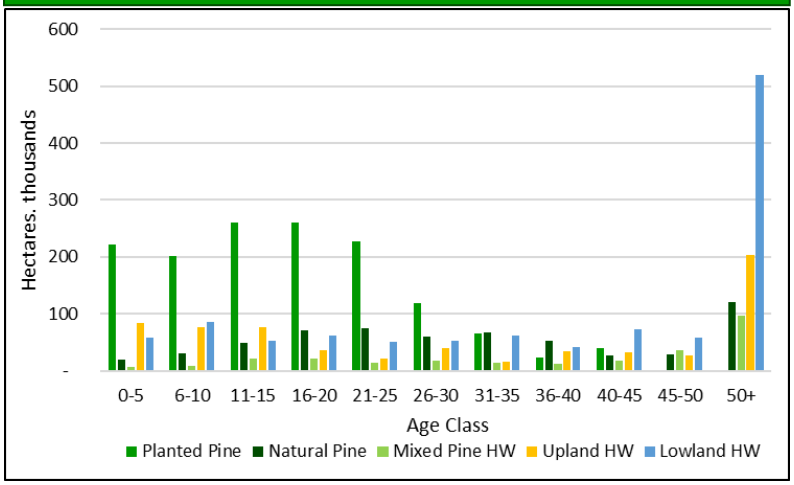
Source: US Forest Service

Historic Timberland Area by Forest Type



Source: US Forest Service

Current Private Timberland Area by Age Class and Management Type



Source: US Forest Service, SOFAC

Appendix D: Assumptions for Growth-and-Yield Model

The forest management strategy simulated with SiMS2012 focused on results that maximized net present value (similar to BLV) on a pre-tax basis. Key assumptions included:

- All planted pine stands can have two thins beginning at age 10 with a final harvest at a minimum of 15 years;
- All pine stands will be reforested two years following harvest with the approved regime;
- First thin volume will be merchandised as pulpwood;
- Average base site index: 19.8 meters (65 ft) @ age 25 (expressed SI 77');
- REAL discount rate for optimization: 5.0%.

The pricing scenarios in the growth and yield model incorporated the active forest management strategy detailed in Figure A. The strategy and costs reflect a common approach employed by forest owners and institutional timberland investors in the region and align with Forisk biennial survey results of silviculture strategies in the U.S. South.

Figure A. Detailed Reforestation Costs

Operation	Cost
Site Prep Costs	**($/Hectacre)**
Burning	$61.78
Chemical Site Prep	$197.68
Total Site Prep	**$259.46**
Planting Costs	**($/Hectacre)**
Seedling Costs (Containerized 2.5Gen, 605TPA)	$172.97
Planting Costs (Machine Plant)	$185.33
Herbaceous Weed Control (Band Early 1st Yr)	$37.07
Total Planting	**$395.37**
Total Cost	**$654.83**

The growth model applied the prices to specific forest products based on the specifications detailed in Figure B.

Figure B. Product Specifications

Product	Min. DBH (cm)	Max. DBH (cm)	Min. Top Diameter (cm)	Include Topwood
Pine Pulpwood	14	61	8	N
Pine Chip-n-saw	19	29	15	N
Pine Large Sawtimber	29	102	20	Y

Source: Timber Mart-South