Historical Perspective on the Relationship between Demand and Forest Productivity in the US South: Executive Summary

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Global Wood & Fiber Supply Chain Experts

Historical Perspective on the Relationship between Demand and Forest Productivity in the US South: Executive Summary

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Forest2Market's mission is to empower participants in the global forest, wood products, paper products, biochemical and bioenergy industries to make exponentially better decisions through the strategic application of industry expertise and unique datasets.

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1 EXECUTIVE SUMMARY

The project sponsors contracted Forest2Market, Inc. to analyze the relationship between demand and forest productivity. Both in terms of standing inventory and annual removals, the US South is the most productive timber-producing region in the United States. Therefore, our analysis focuses on the US South.

Our analysis showed the following:

1. **As demand for forest products has increased, timberlands in the US South have become increasingly productive.** Between 1953 and 2015, annual removals—driven by demand—increased 57 percent from 5.5 to 8.7 billion cubic feet. Simultaneously, annual growth increased 112 percent from 6.8 to 14.4 billion cubic feet.
2. **Increased demand for wood has not depleted forests.** The amount of timberland—unreserved, productive forest land—in the US South has remained stable, increasing by about 3 percent. Because annual growth has outpaced annual removals by an average of 38 percent (GRR=1.38), inventory increased 108 percent from 142.1 to 296.1 billion cubic feet.
3. **Removals increased as consumer demand for wood products grew.** Population growth, higher real Gross Domestic Product and greater utilization of wood for housing construction during periods of economic expansion spurred demand for forest products, including lumber, wood panels, pulp and paper products.
4. **Landowners responded to greater demand by investing in the future growth of their forests.** The forest products industry played a critical role in promoting increases in forest productivity by funding public-private research projects to improve tree genetics and update silvicultural practices, which increased growth and yield, especially on plantation stands. Consistent and increasing demand for forest products assured other private landowners that engaging in more active (and expensive) management practices would provide financial dividends, which ensured more widespread adoption of improved management practices.
5. **The evidence is clear: Increases in removals are associated with more timberland acres, better growth and larger inventories.** Removals have strong, positive, statistically significant correlations with acres, inventory and growth. Regression models that use removals to predict these measures of forest productivity are statistically significant and explain from 65 to 90 percent of the variance in acres, inventory and growth.
6. **Case study evidence confirms that increased removals are associated with increased inventory not only at a regional scale, but also in local wood basins.** Further, they demonstrate that the markets in local wood basins are defined not by changes in demand from a single mill, but rather market-wide shifts in the demand for all wood products, especially sawtimber. However, the case studies also show that when these basins had an active, centrally-located pulpwood-consuming mill, plantation acres increased more quickly, which helped retain total timberland acres in the face of declining naturally-regenerated timberlands.
7. **Today, the biggest threat to forests is urbanization, but this threat can be mitigated by healthy markets for forest products, especially for products from highly-productive plantations.** Nationwide, between 1982 and 2012, development was responsible for almost half (49.2 percent or 17.7 million acres) of all forest land that converted to other land uses.[1] Conversely, forests reclaimed very little (1.2 percent or 0.5 million acres) from developed areas. In the US South, the most productive plantation stands are best protected against conversion: Between 1989 and 1999, 5.4 million acres of stocked timberlands converted to nonforest uses. Of those that did, the overwhelming majority (94 percent) were naturally-regenerated forests, not planted stands.

[1] Total forested acres in the United States increased despite this loss to development only because pastureland, cropland and other land use types converted to forest.

1.1 Key Findings

1.1.1 Key Finding #1

As demand for forest products has increased, timberlands[2] in the US South have become increasingly productive. Between 1953 and 2015, annual removals—driven by demand—increased 57 percent from 5.5 to 8.7 billion cubic feet (Figure 1-1-A). Simultaneously, annual growth increased 112 percent from 6.8 to 14.4 billion cubic feet (Figure 1-1-B).

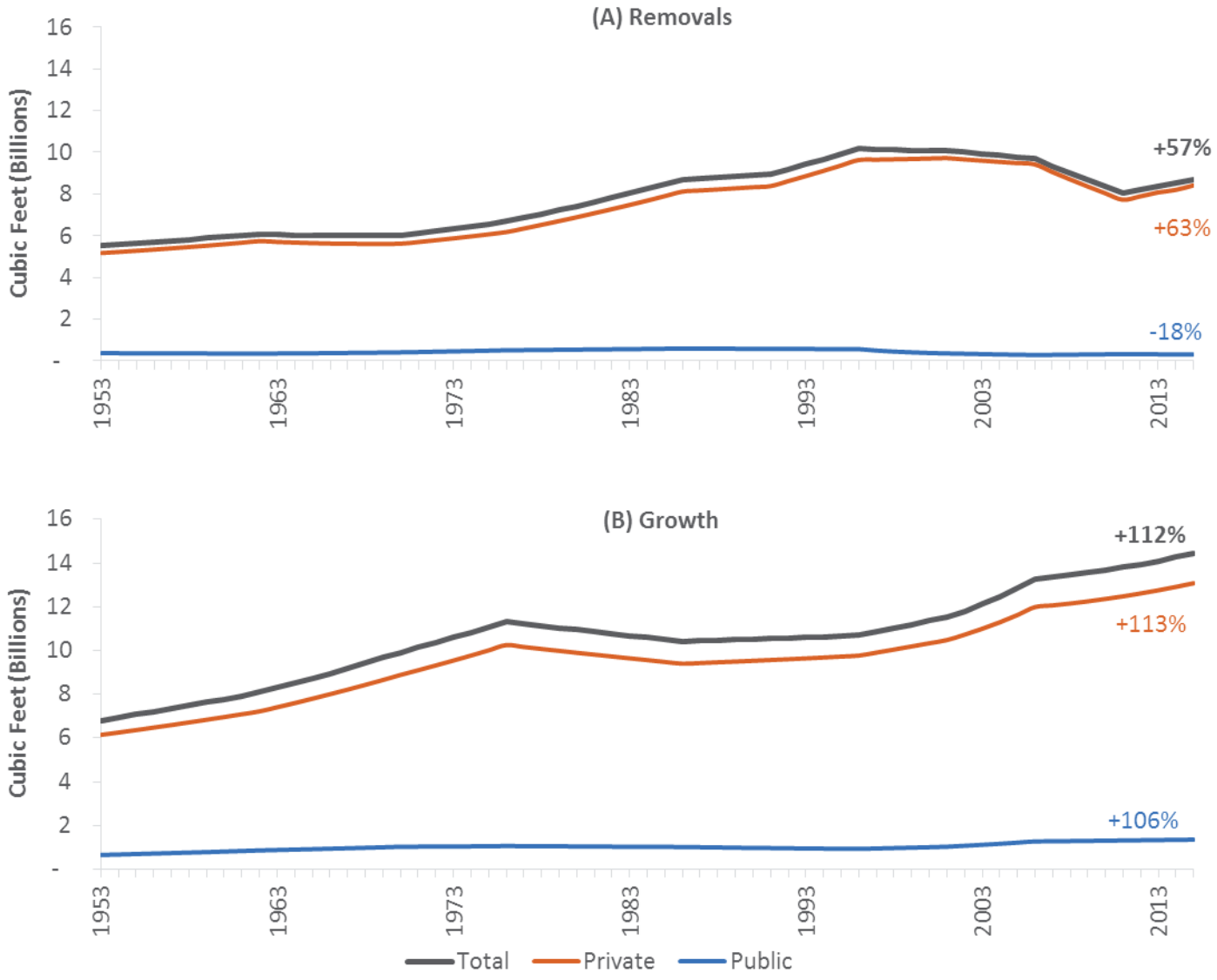

Figure 1-1 Annual Growing-Stock Removals and Growth by Ownership, 1953-2015 – US South
(Sources: US Forest Service Resources Planning Act reports, Forest2Market data and estimates.[3])

[2] Timberland, as used by the FIA, is a subset of forest land defined as "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 at least 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.)"
[3] Data for 1953, 1963, 1970, 1977, 1987, 1997, 2002, 2007 and 2012 are from USFS Resources Planning Act reports. Data for intervening years and 2013-2015 are derived by Forest2Market using annual rates of change between available data years and Forest2Market proprietary transaction data. Growth and removals data include Kentucky.

- Annual removals increased from 5.5 billion cubic feet (BCF) in 1953 to a peak of 10.2 BCF in 1996 driven by increased demand for solid wood, pulp and paper products to support the growing population and economy (Figure 1-1-A). Removals remained at around 10.0 BCF through the late 1990s when technological improvements and increased imports reduced demand for domestically-produced wood products. The Great Recession of 2007 to 2009 caused further declines in wood fiber demand, especially in the solid wood and panel sector, which had previously been buoyed by rapid increases in housing starts during the early 2000s. In response, removals had sunk to around 8.0 BCF by the early 2010s. While removals increased to 8.7 BCF in 2015, they still have not reached pre-Recession levels.
- Annual growth increased at a rate of 1.2 percent annually from 6.8 BCF in 1953 to 14.4 BCF in 2015 in response to improved silvicultural practices and management on private timberlands and declining harvests on public timberlands (Figure 1-1-B). Private, corporate owners realized the biggest productivity improvements as the forest products industry sought to ensure a stable wood supply to support its manufacturing operations, and, after divestiture, financial management organizations sought to maximize the financial return on their timberland investments. Because of their efforts, annual growth increased 259 percent from approximately 1.5 BCF in 1953 to 5.3 BCF in 2015 on corporately-owned timberlands.

1.1.2 Key Finding #2

Increased demand for wood has not depleted forests. Between 1953 and 2012, timberland acreage in the US South has been generally stable and is trending upwards. The amount of timberland—unreserved, productive forest land—in the US South has remained stable, increasing by about 3 percent. Because annual growth has outpaced annual removals by an average of 38 percent (GRR=1.38), inventory increased 108 percent from 142.1 to 296.1 billion cubic feet.

- After increasing from 193.0 million in 1953 to 197.1 million acres in 1963, timberland acreage decreased to 185.3 million acres by 1987 and has since been on an increasing trend (Figure 1-2). By 2012, timberland acreage had reached 197.8 million acres, surpassing its previous 1963 peak. Current timberland acreage in the US South is an estimated 198.9 million acres, a net increase of 5.8 million acres (3 percent) since 1953.
- A decrease of 18.6 million acres (14 percent) in the amount of timberland owned by private, non-corporate owners was offset by a 14.0 million acre (31 percent) increase in corporately-owned[4] timberland and a 10.4 million acre (62 percent) increase in publicly-owned timberland (Figure 1-3).

[4] Until the mid-2000s, the US Forest Service reported private forest ownership under two categories: forest products industry and non-industrial private forest landowners (NIPF). Until this time, land held by Timberland Investment Management Organizations (TIMOs) or Real Estate Investment Trusts (REITs) was classified under the NIPF ownership category. Following the divestiture of many forest products industry lands to TIMOs and REITs in the late 1990s and 2000s, the Forest Service began grouping land held by these management entities together with the remaining lands held by the forest products industry in a new "corporate" category, largely to protect the confidentiality of forest industry owners. For more information on timberland ownership, refer to Section 5.1.

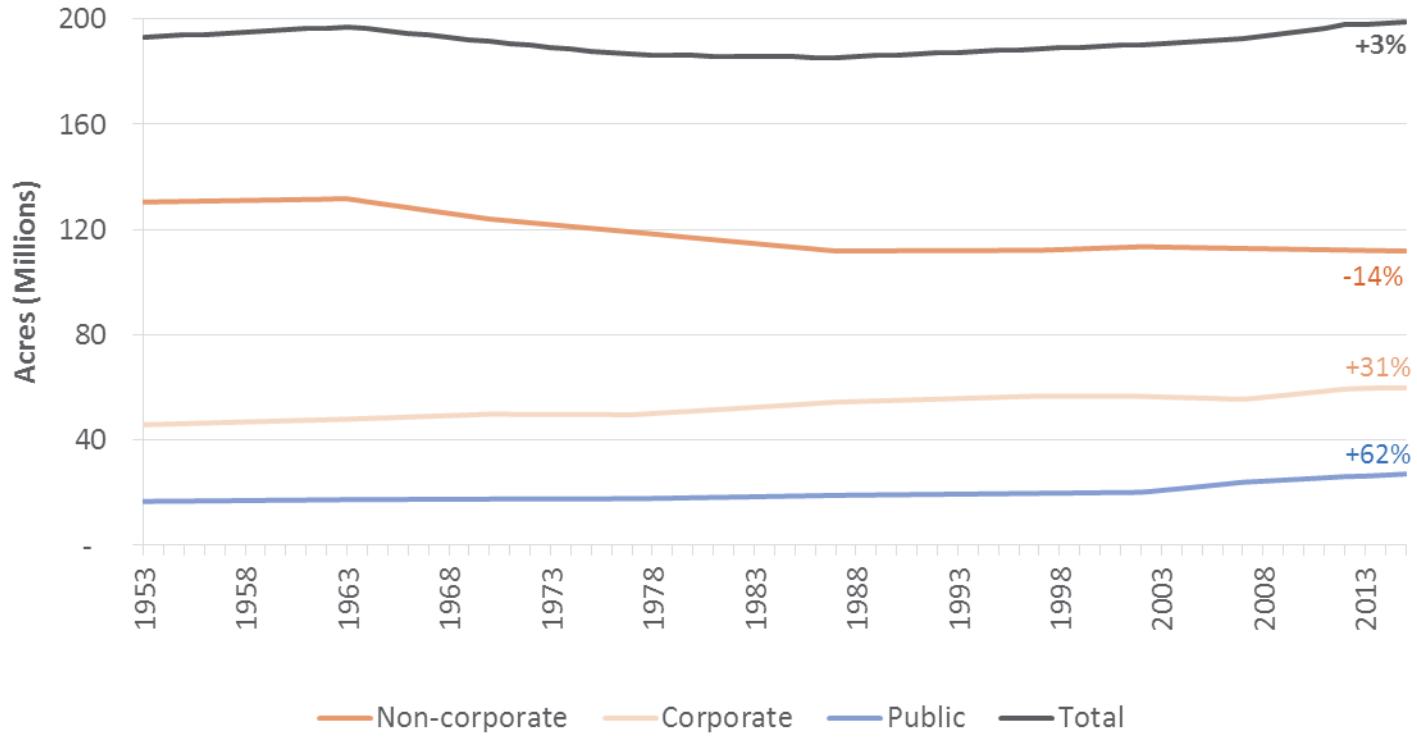

Figure 1-2 Timberland Acres by Ownership Group, 1953-2015
(Sources: US Forest Service Resources Planning Act reports, Forest2Market estimates.[5])

- On average, growth has exceeded removals on US South timberlands by 38 percent since 1953 (Figure 1-3).

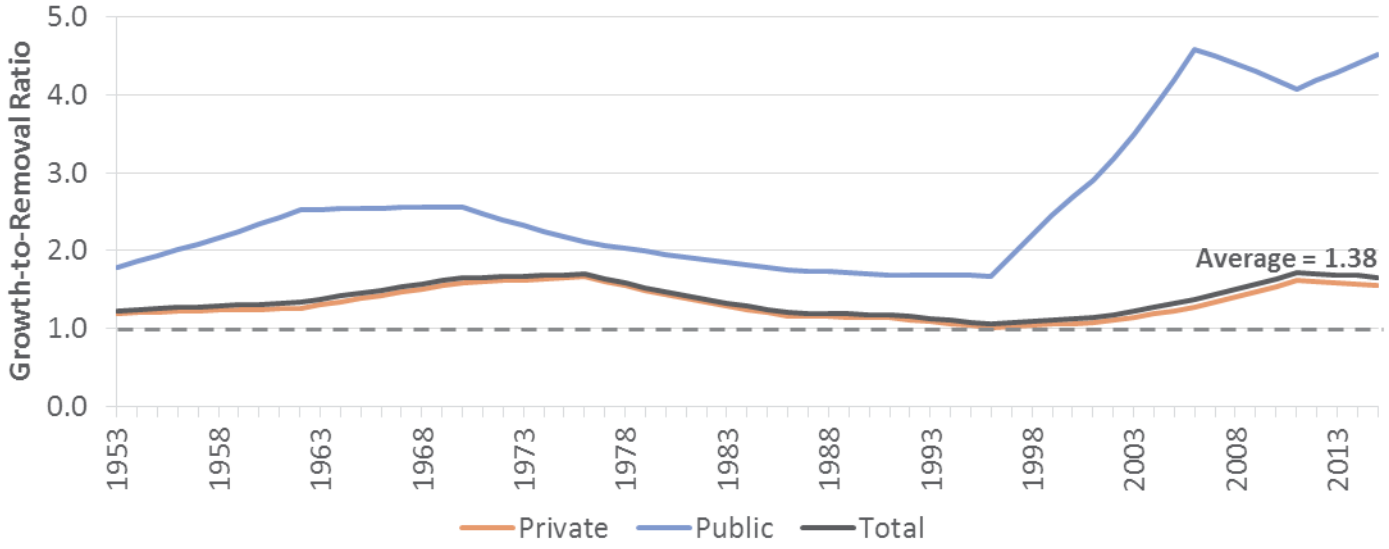

Figure 1-3 Annual Growing Stock Growth-to-Removal Ratios by Ownership, 1953-2015
(Sources: US Forest Service Resources Planning Act reports, Forest2Market data and estimates.[6])

[5] Data for 1953, 1963, 1970, 1977, 1987, 1997, 2002, 2007 and 2012 are from USFS Resources Planning Act reports. Data for intervening years and 2013-2015 are derived by Forest2Market using annual rates of change between available data years and Forest2Market assumptions. Data exclude Kentucky. Also see Section 2.1.

- Because growth predominantly exceeded removals, the forest inventory of the US South continuously increased and more than doubled from 142.1 BCF in 1953 to 296.1 BCF in 2015 (Figure 1-4).

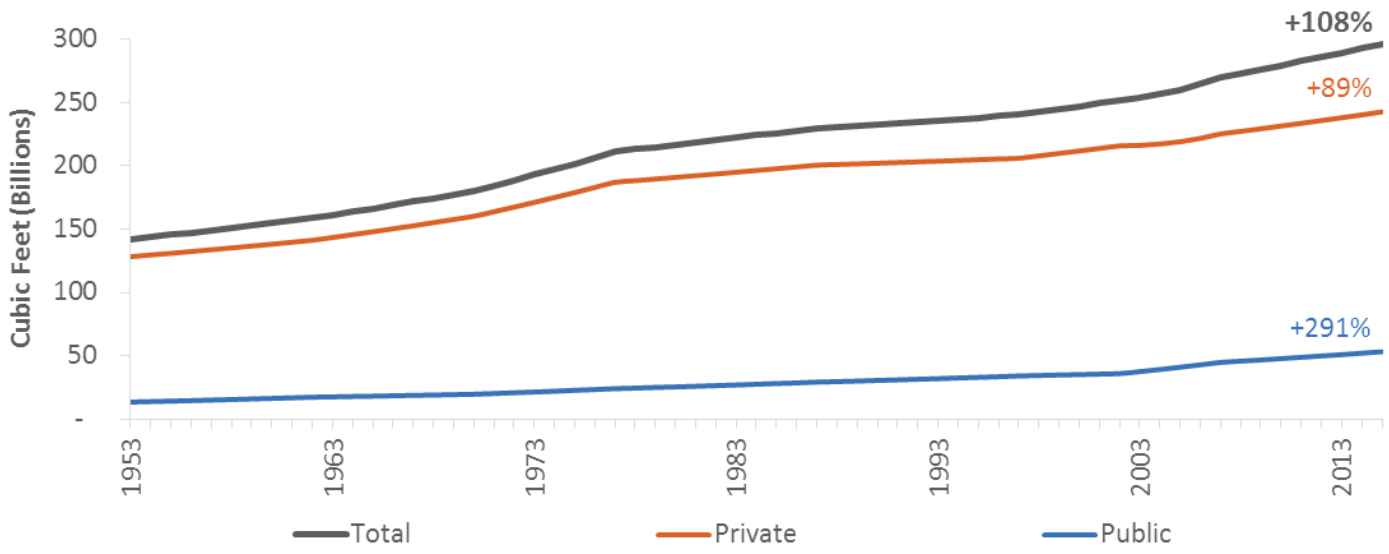

Figure 1-4 Annual Growing-Stock Inventory by Ownership, 1953-2015 – US South
(Sources: US Forest Service Resources Planning Act reports, Forest2Market data and estimates.[7])

1.1.3 Key Finding #3

Removals increased as consumer demand for wood products grew. Increased demand for wood products is the result of population growth, higher real Gross Domestic Product and greater utilization of wood for housing construction during periods of economic expansion. Increased removals since the 1950s were driven by increased demand for wood products, including sawnwood (i.e., lumber), panels (i.e., plywood, particle board), pulp and paper products.

- From 1953 to 2015, US population more than doubled from 159.0 to 321.4 million people, and real GDP increased over six-fold from $2.6 to $16.4 trillion dollars (Figure 1-5-A). These shifts increased the utilization of forest products, including paper, lumber and wood panels.
- While periods of economic expansion and recession caused annual housing starts to fluctuate in the United States, an average of 1.5 million private housing units were started annually between 1959 and 2006 (Figure 1-5-B), a steep increase over the meager 360,000 started annually[8] in the 1930s and 1940s. Homes also became larger: The average size of a single-family home increased from 1,498 square feet in 1965 to 2,687 square feet in 2015 (Figure 1-5-C). Together, these changes increased demand for lumber, plywood and particle board, the staples of American home construction.

[6] Data for 1953, 1963, 1970, 1977, 1987, 1997, 2002, 2007 and 2012 are from USFS Resources Planning Act reports. Data for intervening years and 2013-2015 are derived by Forest2Market using annual rates of change between available data years and Forest2Market proprietary transaction data. Data include Kentucky.
[7] Data for 1953, 1963, 1970, 1977, 1987, 1997, 2002, 2007 and 2012 are from USFS Resources Planning Act reports. Data for intervening years and 2013-2015 are derived by Forest2Market using annual rates of change between available data years and Forest2Market proprietary transaction data. Inventory data exclude Kentucky.
[8] Source: Fedkiw 1989.

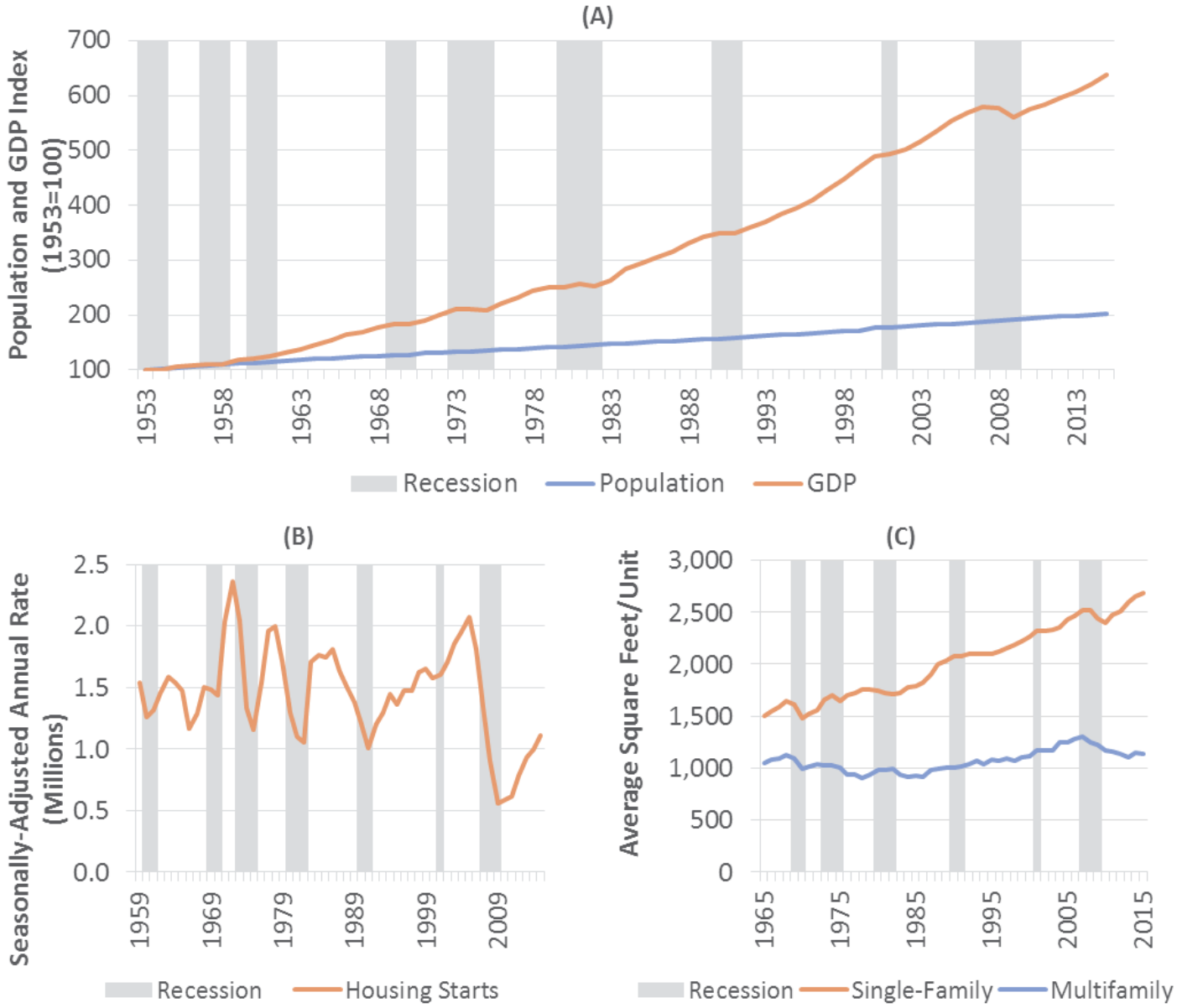

Figure 1-5 Changes in US Population, GDP, Housing Starts and Dwelling Unit Size, 1953-2015
(Sources: US Bureau of Economic Analysis 2016b, US Census Bureau [including data quoted in Howard and Jones 2016], National Bureau of Economic Research.)

- Pulp production peaked in 1994 at 58.4 million metric tonnes, 189 percent above 1961 production. Paper product production increased 237 percent to its peak of 127.6 million metric tonnes in 2007. Sawnwood production increased 67 percent through its peak of 97.0 cubic meters in 2005. Plywood and particle board production increased 321 percent to its peak of 38.5 cubic meters in 1999 (Figure 1-6).

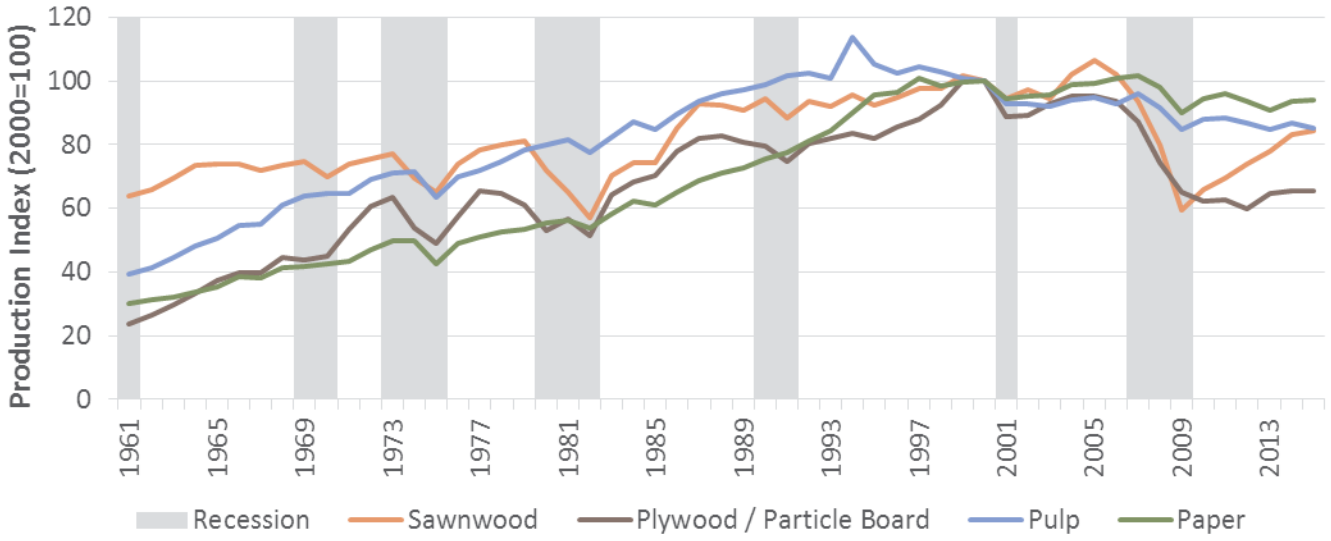

Figure 1-6 US Sawnwood, Panel, Pulp and Paper Production Indices (2000=100) and Economic Recessions, 1961-2015
(Sources: FAO 2016, National Bureau of Economic Research.)

- The Great Recession had a severe negative impact on the forest products industry, especially sawnwood and panel production, which decreased 44 and 35 percent, respectively, between 2005 and 2009 (Figure 1-6, Figure 1-7). Production is gradually improving but has not yet attained pre-Recession levels.

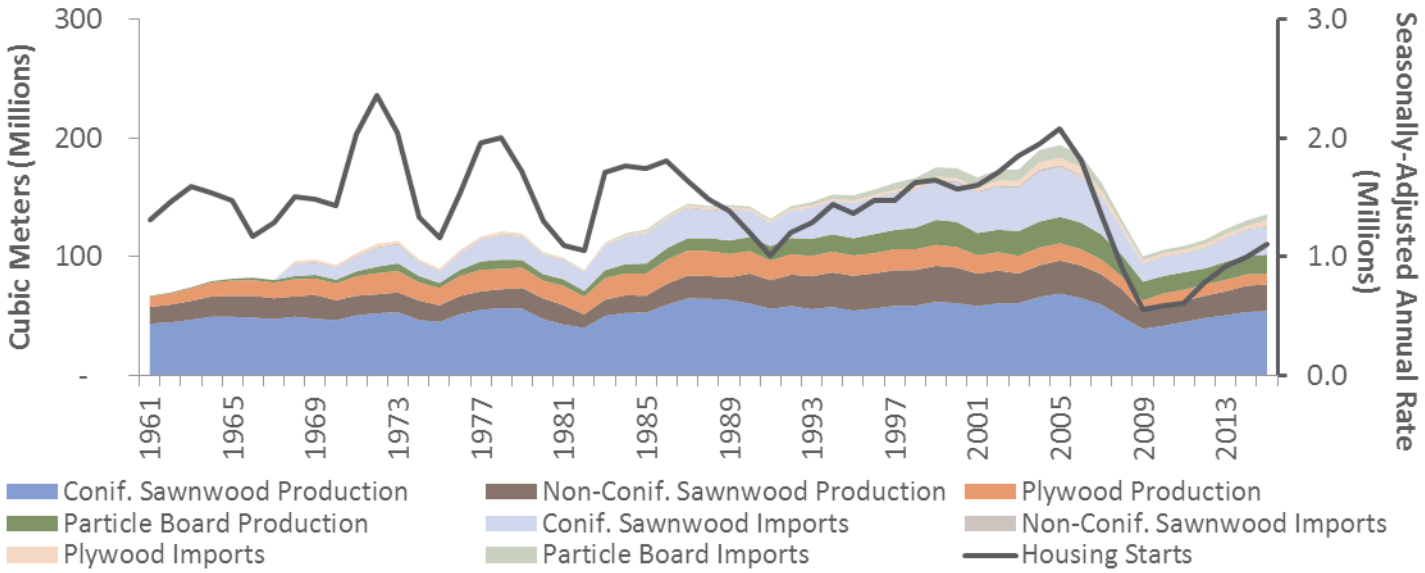

Figure 1-7 US Solid Wood and Panel Production Output and Imports vs. Housing Starts, 1961-2015
(Sources: FAO 2016, US Census Bureau.[9])

- While industrial wood pellet production in the United States has increased dramatically since 2009, its rate of growth has moderated and remains dwarfed by pulp and paper production (Figure 1-8).

[9] FAO import data is unavailable prior to 1968. Note: Particle board includes Oriented Strand Board (OSB).

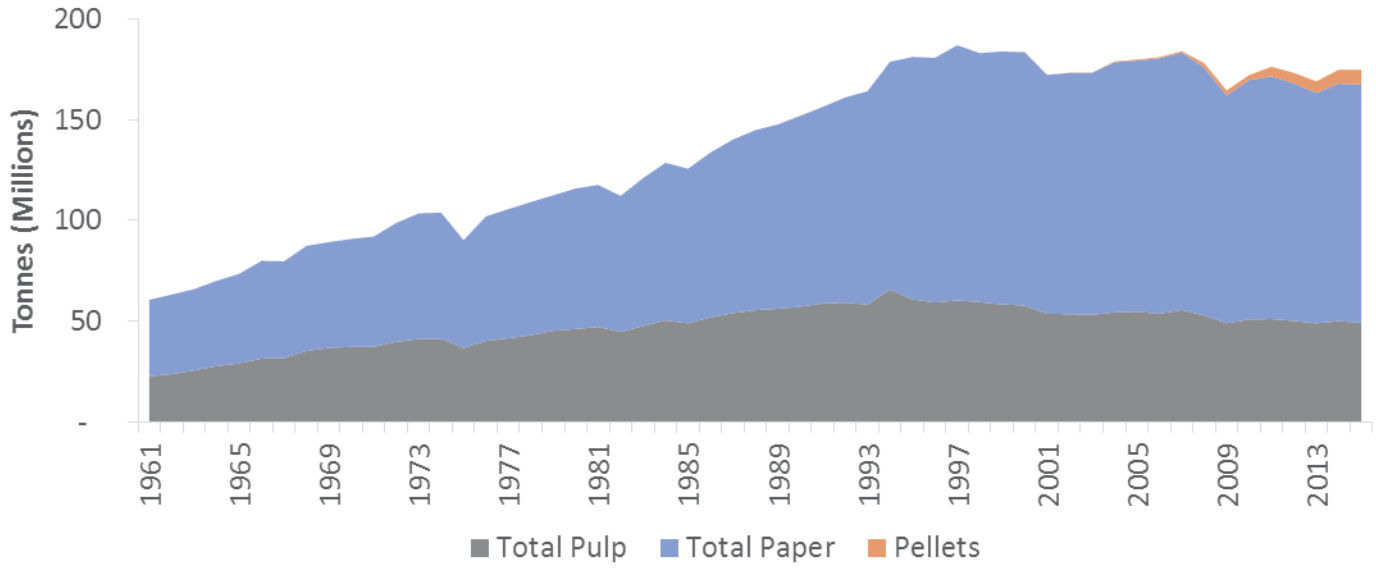

Figure 1-8 Total US Pulp, Paper and Pellet Production, 1961-2015
(Sources: FAO 2016, Forest2Market data and estimates.)

1.1.4 Key Finding #4

Landowners responded to greater demand by investing in the future growth of their forests. The forest products industry played a critical role in promoting increases in forest productivity by funding public-private research projects to improve tree genetics and update silvicultural practices, which increased growth and yield, especially on plantation stands. Consistent and increasing demand for forest products assured other private landowners that engaging in more active (and expensive) management practices would provide financial dividends, which ensured more widespread adoption of improved management practices.

- The rapid increases in Southern inventory since the 1950s coincided with consistent increases in forest products demand and removals through the mid-2000s. This increase in inventory alongside increasing removals on a relatively stable base of timberland acres could not have occurred without larger increases in growth.
- Private landowners have held an average of 90 percent of Southern timberland since 1953. Private owners' actions, therefore, are largely responsible for changes in forest productivity.
- To ensure stable and increasing supplies of raw material, the forest products industry made significant investments in timber production. Throughout the latter half of the twentieth century, the industry invested in collaborative public-private research programs to promote forest productivity.
- As a result of improved silvicultural practices, the output of plantations increased almost fourfold from 90 cubic feet per acre per year in the 1950s and 1960s to 350 cubic feet per acre per year in the 2000s (Figure 1-9).
- New knowledge and technology related to forest management and silvicultural practices were then passed on to non-industrial private landowners via landowner assistance programs. Government policies also promoted the retention and expansion of privately-owned timberland through land conservation policies, most notably the Soil Bank Act of 1956, which established the Conservation Reserve Program, and the 1985 Farm Bill, which reinstated it.

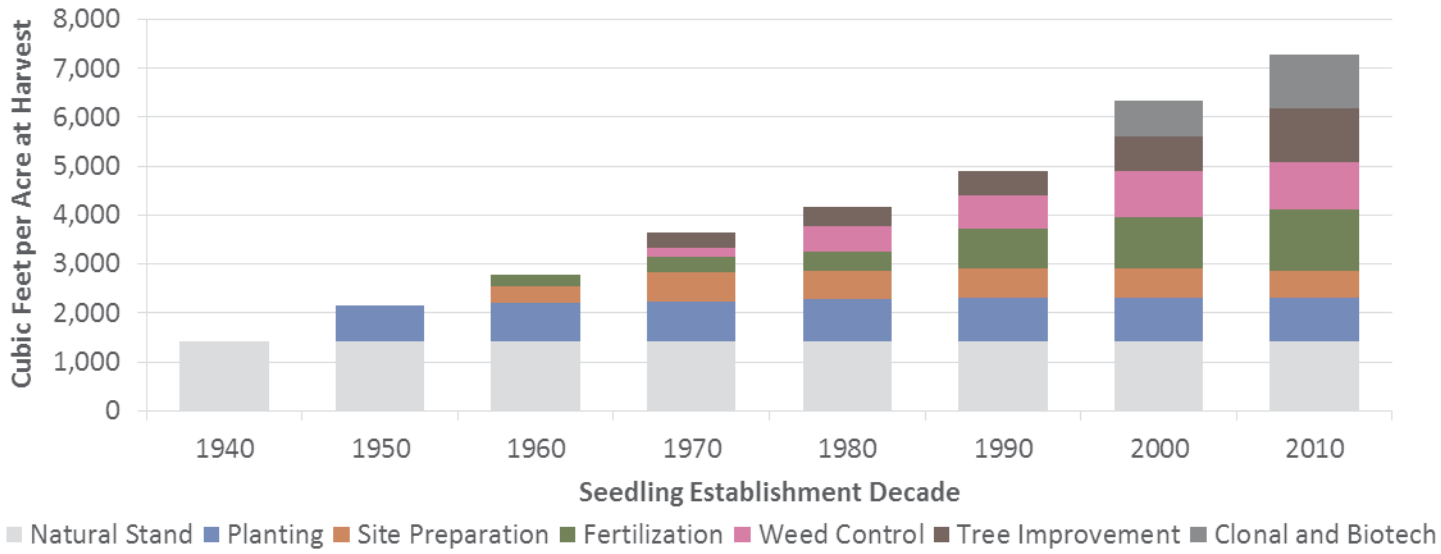

Figure 1-9 Estimated Contributions of Intensive Management Practices to Productivity in Pine Plantations in the US South, 1940-2010
(Source: Fox, Jokela and Allen 2004.[10])

- In total, growth per acre on private stands increased 118 percent from 35 cubic feet per acre in 1953 to 76 cubic feet per acre in 2015. In contrast, growth per acre on public stands increased just 27 percent from 39 to 50 cubic feet per acre (Figure 1-10).

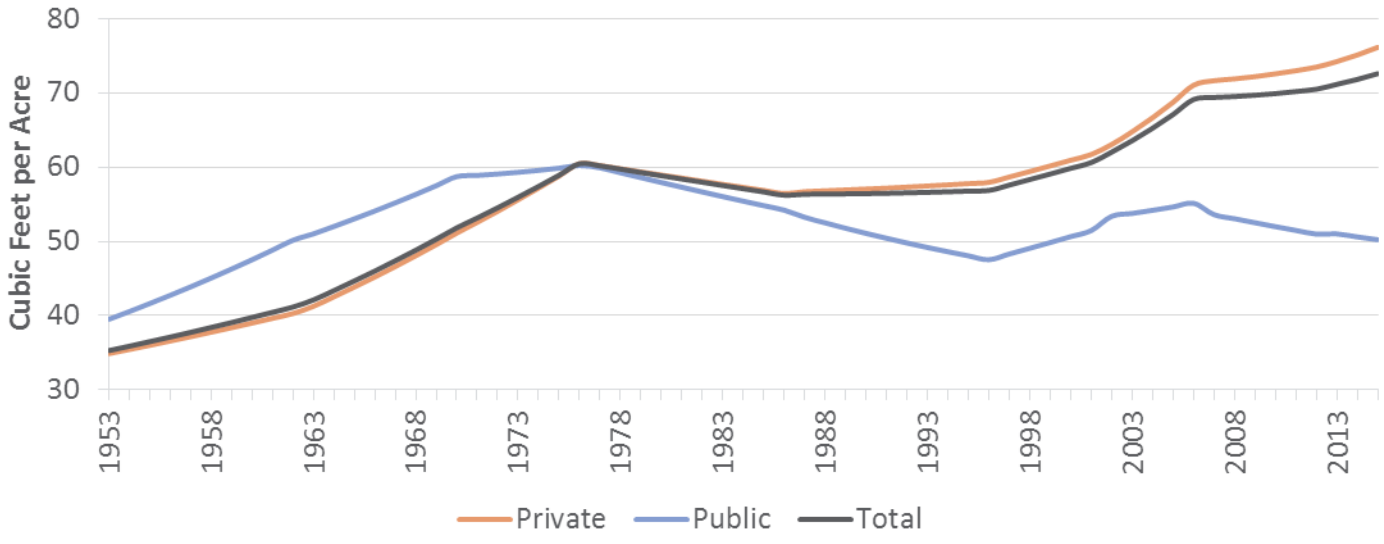

Figure 1-10 Annual Growing Stock Growth per Acre on Timberland by Ownership, 1953-2015
(Sources: US Forest Service Resources Planning Act reports, Forest2Market estimates.[11])

[10] Notes: Adapted from Figure 8.3 of original source. Data in the chart are approximated and may not be perfectly to scale. Approximate tons were converted to cubic feet using a conversion factor of 1 ton ≈ 34.48276 cubic feet. Data in the chart correspond to total harvest and are different than the annual yield data reported in text: Dividing totals in the chart by 15 would approximate the average annual productivity of plantations established at different times assuming a 15-year rotation.

- Driven by the desire to maximize productivity and government policies that encouraged planting, landowners—especially private landowners—increased their utilization of plantation pine management types (Figure 1-11). As a result, planted pine increased from 1 percent of timberland acreage in 1953 to 19 percent in 2010.
- The amount of timberland in hardwood management types increased by 6.3 million acres between 1953 and 2010; a decrease of 5.9 million acres of lowland hardwood timberlands was offset by an increase of 12.3 million acres of upland hardwood timberlands.[12]

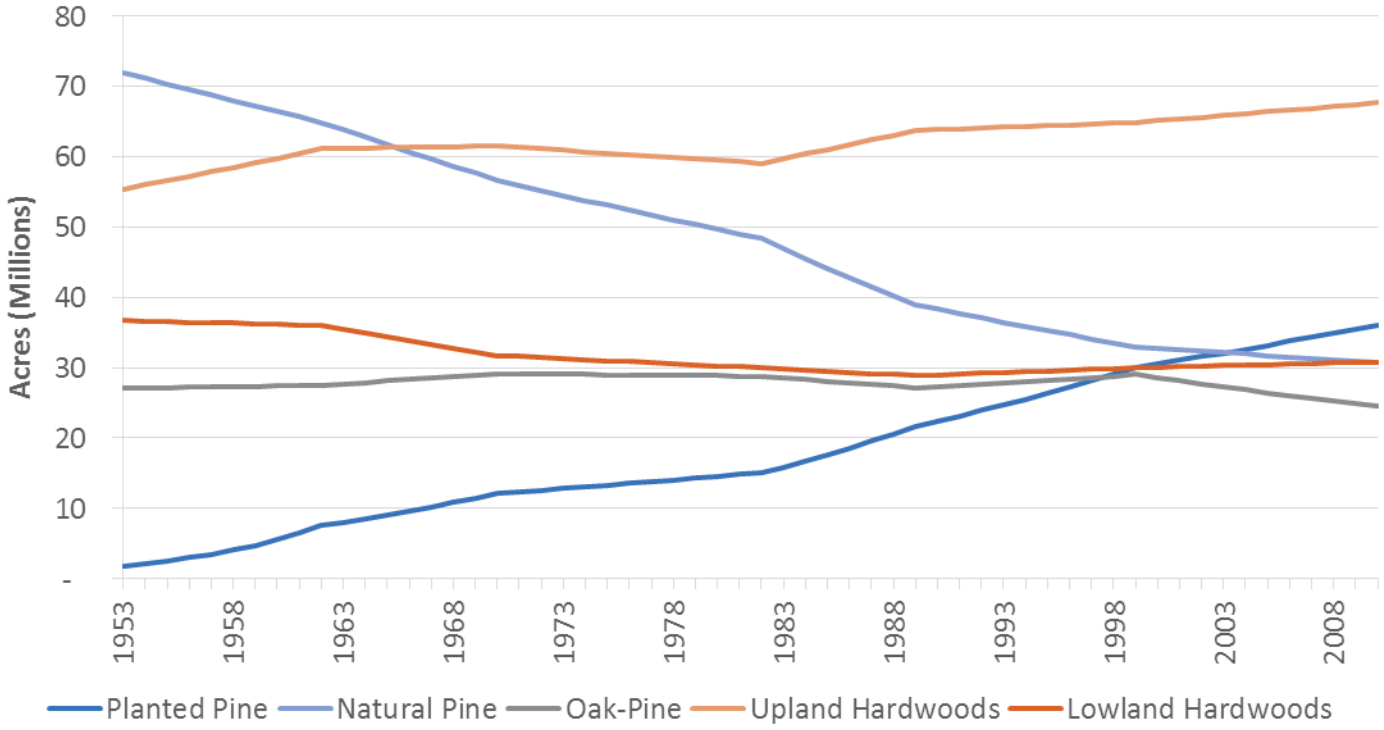

Figure 1-11 Annual Timberland Acres by Forest Management Type, 1953-2010 – All Ownerships
(Sources: Conner and Hartsell 2002, Hartsell and Conner 2013, Forest2Market estimates.[13])

[11] Data for 1953, 1963, 1970, 1977, 1987, 1997, 2002, 2007 and 2012 are from USFS Resources Planning Act reports. Data for intervening years and 2013-2015 are derived by Forest2Market using annual rates of change between available data years and Forest2Market assumptions. Growth data include Kentucky; acreage data exclude Kentucky.
[12] May not sum to total due to rounding.
[13] Data for 1953, 1962, 1970, 1982, 1989, 1999 and 2010 from Conner and Hartsell 2002 and Hartsell and Conner 2013. Data for intervening years are derived by Forest2Market using annual rates of change between available data years. Data are for all ownerships and exclude nonstocked stands and Kentucky acreage. Also see Section 2.1.

- Neither all of the gain in plantation pine stands, nor all of the loss in natural stands can be attributed to conversion from natural to plantation management. While it is true that some naturally-regenerated stands are being converted to plantations, it is also true that nonforested stands are being converted to plantations and that natural stands are being converted to nonforested uses. Forest management data from 1989 to 1999 show that forest management practices are largely stable over the medium-term and that shifts in management types over time are more nuanced (Table 1-1).

Table 1-1 Ten-Year Trends in Forest Management Types on Areas that were Timberland in 1989
(Source: Conner and Hartsell 2002)

Status in 1989		Status in 1999						
Forest Management Type	Total Acres (Thousands)	Remained Plantation	Remained Natural	Remained Nonstocked	Became Plantation	Became Natural	Became Nonstocked	Became Nonforest
Planted Pine/Oak-Pine	24,798	89%				10%	0.1%	1%
Natural Pine	40,104		88%		8%		0.1%	3%
Natural Oak-Pine	23,850		92%		5%		0.0%	3%
Upland Hardwood	65,906		91%		6%		0.1%	3%
Lowland Hardwood	29,817		95%		2%		0.1%	3%
Nonstocked	75			29%	40%	21%		9%

1.1.5 Key Finding #5

The evidence is clear: Increases in removals are associated with more timberland acres, better growth and larger inventories. Analyses of privately-owned timberland in Southern states show that the observed historical relationships between Southwide demand and productivity are statistically significant.[14] Removals have strong, statistically significant, positive correlations with acres, inventory and growth, especially for softwood species (Table 1-2). Models that use removals to predict acres, inventory and growth are also statistically significant and explain between 65 and 90 percent of the variance in acres, inventory and growth (Figure 1-12).

- Removals are strongly and significantly positively correlated with timberland acres on a same-species basis (r=0.93 for softwood and r=0.81 for hardwood). Private softwood removals describe approximately 87 percent of the variance in private softwood acres. Hardwood removals explain less of the variance (66 percent) in hardwood acres.
- The strong, significant, positive correlations between removals and inventory are even stronger than those observed between removals and acres for softwood species: Softwood removals have an almost perfect positive correlation (r=.95) with softwood inventory. Private softwood removals describe approximately 90 percent of the variance in private softwood inventory. While somewhat smaller, hardwood removals still have a strong positive correlation (r=.80) with hardwood inventory. Hardwood removals explain approximately 65 percent of the variance in hardwood inventory, less than the variance in softwood inventory explained by softwood removals.

[14] In order to maintain consistency with published US Forest Service reports, this report used Southwide historical removals, inventory, growth and acres information sourced primarily from US Forest Service Resources Planning Act (RPA) reports, which are published every five to ten years. While some state-level data are available in the RPA reports, most forest metrics are based on the entire Southern region. Attempting statistical analyses on the regional RPA data would have limited the analysis to fewer, region-level data points. By analyzing individual inventory years of state-level data from the US Forest Service Forest Inventory and Analysis dataset, we were able to build a much more robust dataset for analysis. It should be noted that each point in the scatterplots that appears in corresponds to a single year of state-level inventory data and does not bear any direct relationship to the historical Southwide totals. For more information about the data source and methodology for the statistical analyses, see the introduction to Section 6.

- Removals are strongly and significantly positively correlated with growth on a same-species basis (r=0.91 for softwood and r=0.84 for hardwood). Private softwood removals explain approximately 84 percent of the variance in softwood growth. Hardwood removals explain a lower percentage of the variance (71 percent) in hardwood growth.
- There are several reasons why softwood removals bear a stronger relationship to acres, growth and inventory. First, plantations, which largely occur on softwood stands, typically are managed to maximize output to produce a steady supply of wood and/or to promote predictable financial returns; other objectives, such as recreation and wildlife habitat may be secondary. Plantation stands require more upfront financial investment (i.e., stand preparation, planting and upkeep costs), but they are also associated with high growth and more regular harvesting. Second, softwood species also have shorter harvest rotations than hardwood species. Third, hardwood stands, especially those owned by non-industrial private landowners, may be managed with more diverse management objectives, and timber output may not be the landowner's primary goal.

Table 1-2 Pearson Correlations between Removals and Acres, Inventory and Growth by Species, 1968-2015
(Sources: US Forest Service Forest Inventory and Analysis database, Forest2Market calculations.)

Pearson Correlations (p-values)								
Softwood Removals			**Hardwood Removals**			**Total Removals**		
Softwood Acres	0.93056	(p<.0001)	Hardwood Acres	0.81413	(p<.0001)	Total Acres	0.88763	(p<.0001)
Softwood Inventory	0.95007	(p<.0001)	Hardwood Inventory	0.80486	(p<.0001)	Total Inventory	0.79217	(p<.0001)
Softwood Growth	0.91452	(p<.0001)	Hardwood Growth	0.84462	(p<.0001)	Total Growth	0.90229	(p<.0001)

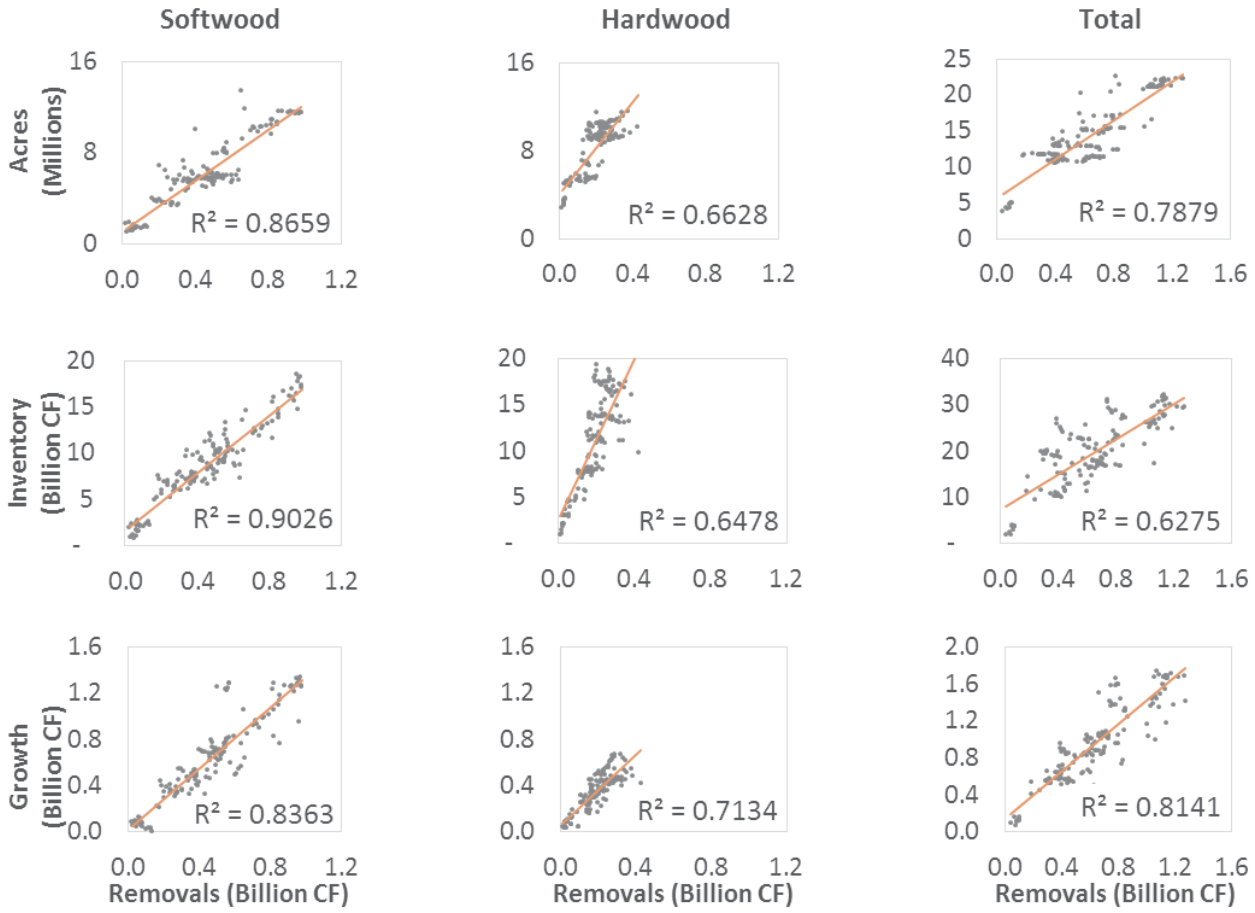

Figure 1-12 Private Removals vs. Acres, Inventory and Growth by Species, 1968-2015
(Sources: US Forest Service Forest Inventory and Analysis database, Forest2Market calculations.)

1.1.6 Key Finding #6

Case study evidence confirms that increased removals are associated with increased inventory not only at a regional scale, but also in local wood basins. Further, they demonstrate that the markets in local wood basins are defined not by changes in demand from a single mill, but rather market-wide shifts in the demand for all wood products. In particular, shifts in demand for larger and more valuable sawtimber had a greater impact on case study forests and markets than did changes in demand associated with individual pulpwood-consuming mills. However, the case studies also show that when these basins had an active, centrally-located pulpwood-consuming mill, plantation acres increased more quickly, which helped retain total timberland acres in the face of declining naturally-regenerated timberlands.

- Case studies of wood basins surrounding the Flint River, Georgia and St. Joe, Florida areas from the 1970s to 2015 show that these local wood basins tended to follow larger Southwide trends despite the fact that Flint River experienced the opening (in 1981) and St. Joe experienced the closing (in 1998) of a pulpwood-consuming mill. In both areas, removals, growth and inventory associated with both sawtimber and pulpwood increased over the study period (Figure 1-13). These localized findings are consistent with Southwide historical trends and statistical results linking increased removals to increased inventory.

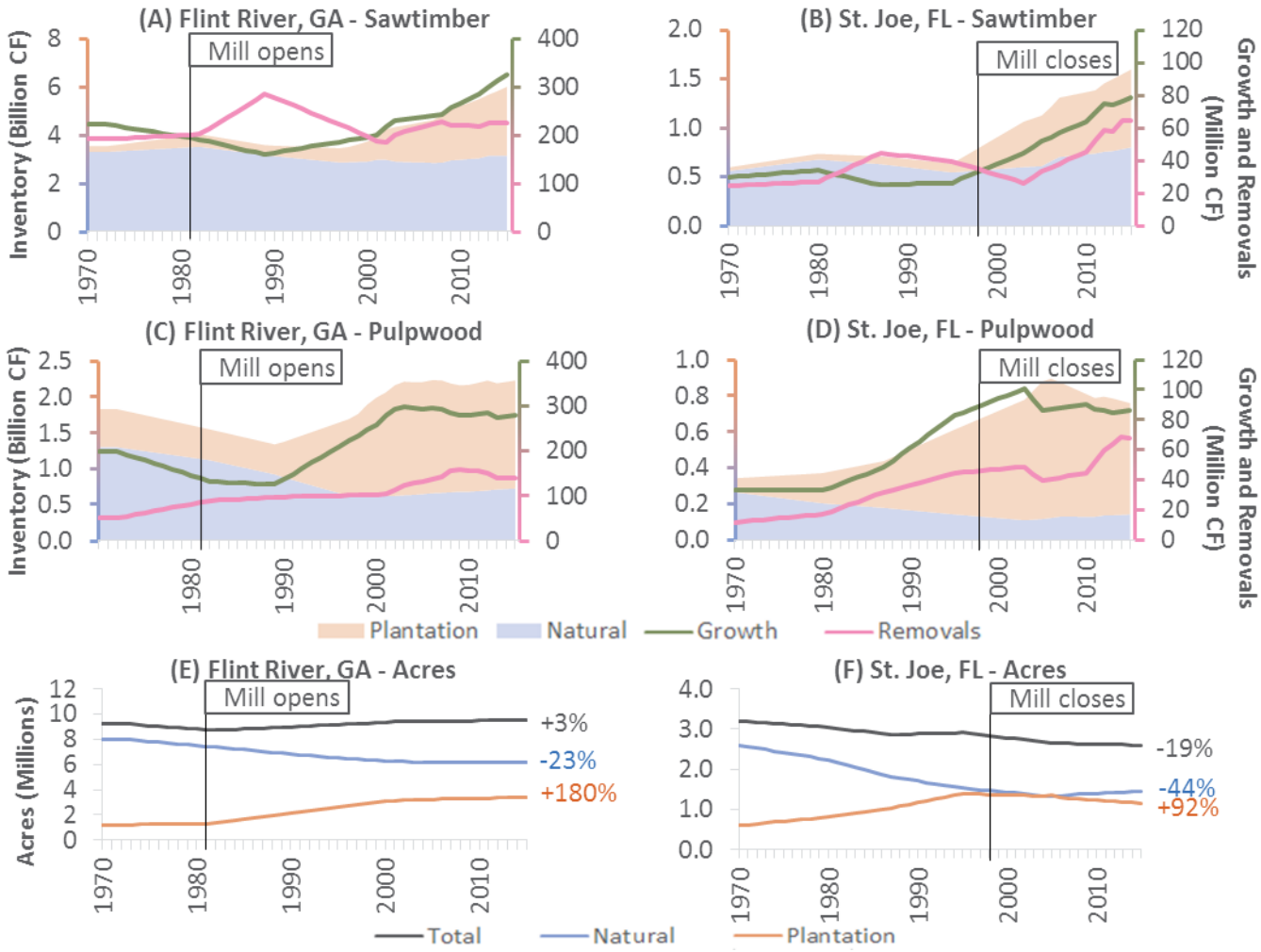

Figure 1-13 Annual Inventory, Growth, Removals and Acres in the Flint River, GA and St. Joe, FL Basins, 1970-2015
(Source: US Forest Service Forest Inventory and Analysis Database.)

- In both basins, inventory, growth and removals were driven not by a single pulpwood-consuming mill; rather, they were shaped by regional trends and the actions of all local market participants, especially sawtimber consumers.
    - First, the case studies failed to demonstrate that the opening or closing of a single-pulpwood consuming mill had the power to interrupt or reverse trends in pulpwood removals in these local markets. In both basins, trends of increasing pulpwood removals, which existed prior to the pulpwood-consuming mill opening (in Flint River, Figure 1-13-C) or closing (in St. Joe, Figure 1-13-D), continued after these mill events because other consumers were active in these basins.
    - Second, because sawtimber-sized trees represented the majority of removals and inventory in both basins (Figure 1-13) and because sawtimber has historically been a higher-value product (Figure 1-14), shifts in sawtimber demand had the power to produce greater impacts on local forests than did changes in pulpwood demand. For example, in both basins, increasing sawtimber demand in the 1980s[15] was followed by an expansion in plantation acres, which led to dramatically increased growth and inventory, first in smaller-diameter pulpwood)and later in larger-diameter sawtimber trees (Figure 1-13). Further, the Flint River case study supports previous Forest2Market findings[16] that reduced sawtimber demand associated with the Great Recession caused landowners to defer final harvests until sawtimber market conditions improve, which limited pulpwood regeneration and inventory.

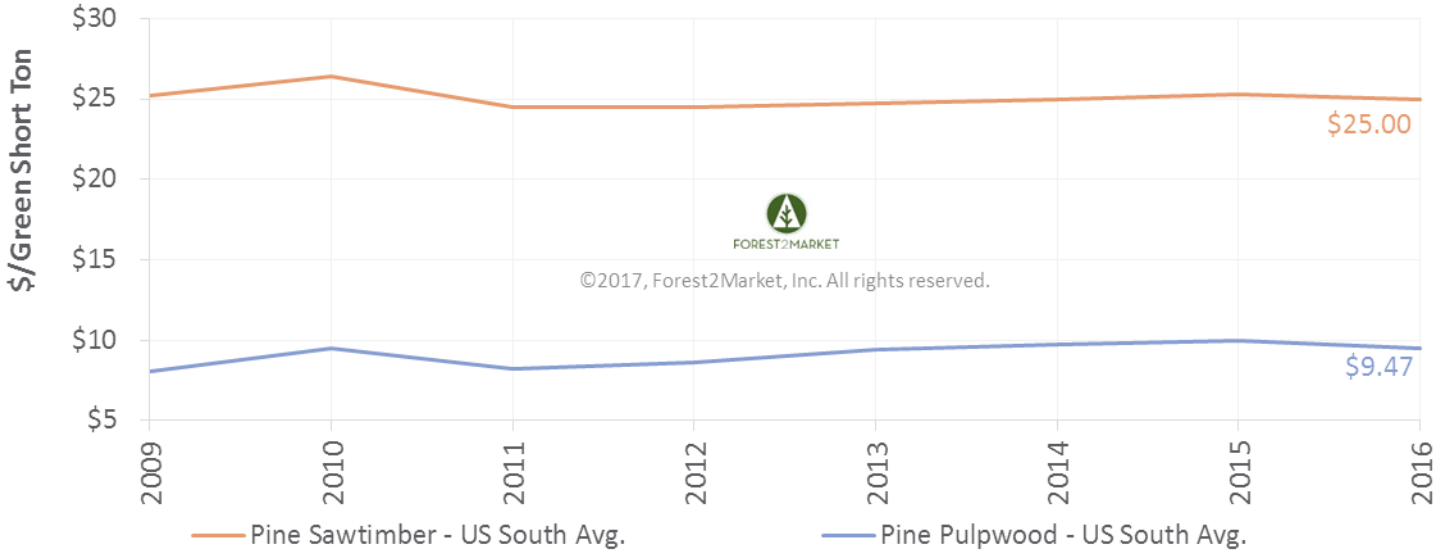

Figure 1-14 Annual Pine Sawtimber and Pulpwood Stumpage Prices in the US South, 2009-2016
(Source: Forest2Market, Inc.[17])

- As in the US South, naturally-regenerated acres declined in both basins while plantation acres increased (Figure 1-13). However, the case studies suggest when basins have an active, centrally-located pulpwood-consuming mill, plantation acres increase more rapidly, which helps to retain total timberland acres: In both basins, plantation acres increased more quickly when the central mill was active, which allowed total timberland acres to increase at a faster rate (in Flint River) and decrease more slowly (in St. Joe) (Table 1-3).

[15] Government incentives from the Conservation Reserve Program also contributed.
[16] See, for example, Stewart 2015 and Stuber 2016.
[17] Prices are annual averages of bimonthly prices reported in Forest2Market's Timber Owner Market Guide (TOMG) and are sourced from our proprietary databases of stumpage transactions.

Table 1-3 Annual Change in Timberland Acres by Stand Origin During Periods When a Central Pulpwood-Consuming Mill was Active and Inactive in the Flint River, GA and St. Joe, FL Basins, 1970-2015
(Source: US Forest Service Forest Inventory and Analysis Database.)

	Time Period	Mill Status	Natural	Plantation	Total
Flint River, Georgia	1972-1981	Inactive	▼ -0.8%	▲ 1.0%	▼ -0.6%
	1981-2015	Active	▼ -0.5%	▲ 2.8%	▲ 0.3%
	1972-2015		▼ -0.6%	▲ 2.4%	▲ 0.1%

	Time Period	Mill Status	Natural	Plantation	Total
St. Joe, Florida	1970-1998	Active	▼ -2.0%	▲ 3.0%	▼ -0.4%
	1998-2015	Inactive	▼ -0.1%	▼ -1.0%	▼ -0.5%
	1970-2015		▼ -1.3%	▲ 1.5%	▼ -0.5%

1.1.7 Key Finding #7

Today, the biggest threat to forests is urbanization, but this threat can be mitigated by healthy markets for forest products, especially for products from highly-productive plantations. Nationwide, between 1982 and 2012, development was responsible for almost half (49.2 percent or 17.7 million acres) of all forest land that converted to other land uses. Conversely, forests reclaimed very little land (1.2 percent or 0.5 million acres) from developed areas. In the US South, the most productive plantation stands are best protected against conversion.

- Nationally, overall forest land acreage increased 0.7 percent while developed land acreage increased 58.7 percent. Across the United States, approximately 39.1 million acres were converted to forests from other uses. At the same time, however, 36.0 million acres of forest land were lost to other uses.
    - Most of the acres that were converted to forest land were previously pastureland (19.8 million acres, 50.8 percent), cropland (10.3 million, 26.4 percent) or other rural land (3.7 million, 9.5 percent). Only 1.2 percent (0.5 million acres) was previously developed land.[18] Rarely does developed land become forest.
    - Of the forest land that was lost, most was converted to developed land (17.7 million acres, 49.2 percent), pastureland (5.8 million, 16.0 percent) or water areas or Federal land (4.7 million, 13.1 percent). These data show that over the past thirty years, the biggest threat to forests has been urbanization.
- Between 1989 and 1999, 5.4 million acres of stocked timberlands in the US South were converted to nonforest uses. Most (94 percent) were previously naturally-regenerated forest management types. Only 6 percent was previously planted pine/oak-pine.

Table 1-4 Timberland Acres Converted to Nonforest in 1999 by 1989 Forest Management Type
(Source: Connor and Hartsell 2002)

1989		1999	
Forest Management Type	Acres (Thousands)	Nonforest Acres (Thousands)	Percent Converted to Nonforest
Planted Pine/Oak-Pine	24,798	300	1%
Natural Pine	40,104	1,394	3%
Natural Oak-Pine	23,850	660	3%
Upland Hardwood	65,906	2,210	3%
Lowland Hardwood	29,817	864	3%
Nonstocked	75	7	9%
Total	184,550	5,435	3%

[18] For definitions of the various land use types, refer to Section 3.5.

1.2 Conclusion

Our historical analysis demonstrates a strong relationship between demand, forest productivity and, ultimately, inventory. The rapid increases in inventory over the past 75 years coincided with consistent increases in forest products demand through the mid-2000s. Productivity and output improvements were a result of the concerted efforts by the forest products industry to improve yield via improved tree genetics, silvicultural treatments and management practices. This is especially true for softwood species, which are often more actively managed. Government programs to promote reforestation and prevent soil erosion also contributed to the establishment and replanting of timber on non-industrial lands.

Our statistical analyses show clear links between removals and growth, removals and inventory and removals and acres. We argue that these attributes operate together to cause changes in forest inventories. Much as it was at the turn of the twentieth century when Southern forests had largely been cut-over,[19] inventory—more specifically, the lack of inventory—can function to limit removals. High demand promotes investment in, and management of, timberland acres, improvements in growth and the building of timber inventories, as it did during the second half of the twentieth century. However, it is not possible to increase removals and maintain or build inventory unless growth and/or forested acres also increase. For the US South, increased growth is the link between increased demand and increased inventory because the forested area has remained stable. Foresight, planning and constructive action by the forest products industry and other private landowners were instrumental in ensuring that the South's forest inventory continued to grow and remain sustainable as demand for forest products increased.

Since the 1950s, the South's forests have demonstrated their ability to adapt to changes in demand without experiencing declines, and forest owners, who are predominantly private individuals, families, corporations and investors, have demonstrated their ability not only to use and maintain, but also to replenish and grow, the forest.

At the same time, forests face competing pressures, not least of which is urbanization. Looking to the future, one US Forest Service report (Wear and Greis 2012, Wear and Gries 2013) forecasted the cumulative change in non-Federal forest land in the South through 2060 under four different scenarios. The scenarios differed in the degree of urbanization and the future value of timber, two important factors that will affect the future of forests. The results of the Forest Service analysis showed that the South was projected to lose between 7 to 13 percent of its forest land by 2060 (Figure 1-15).

However, the amount of forest land lost varied depending on the amount of urbanization and the changing future value of timber. The authors of the report wrote:

> Between 30 million and 43 million [additional] acres of land in the South are forecasted to be developed into urban uses by 2060, from a base of 30 million acres [of urban land that existed] in 1997. The South is forecasted to lose between 11 million and 23 million acres (7 and 13 percent, respectively) of forests from 1997 to 2060. All subregions are expected to lose at least some acreage; nearly all of this area would be converted to urban uses. Strong timber markets can ameliorate forest losses somewhat, by shifting urbanization to agricultural lands. (Wear and Greis 2012, 24)

[19] According to some estimates, by 1920, over 156 million acres in thirteen southern states had been cut-over (i.e., cleared completely of forest), and only 24 million acres of old-growth pine remained in the yellow pine area from South Carolina to Texas (Boyd 2001). At the time, annual cut exceeded growth by a factor of three (Boyd 2001).

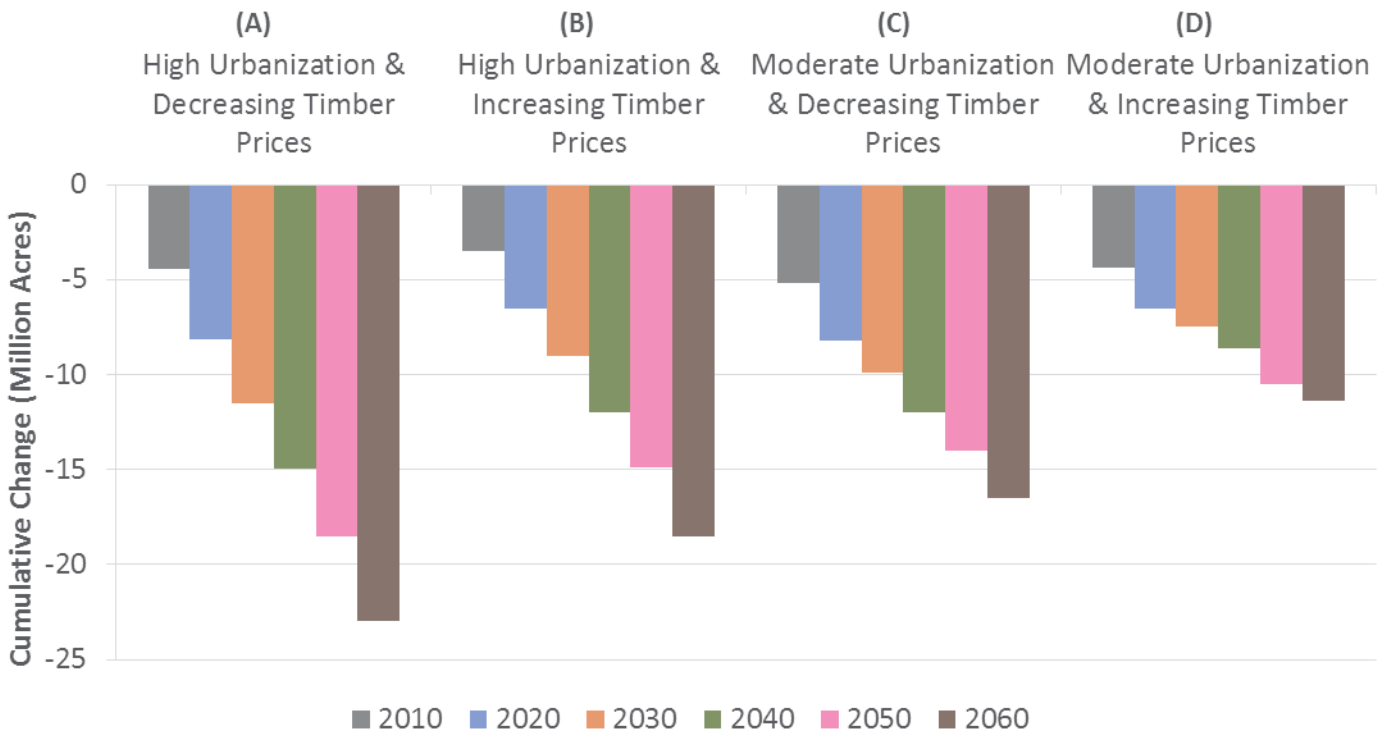

Figure 1-15 Cumulative Change in Forest Land Uses from 1997 to 2060 by Decade under Four Scenarios
(Source: Wear and Greis 2013.[20])

In the Forest Service analysis, higher urbanization and decreasing prices for timber resulted in the most forest land loss (Figure 1-15-A). Moderate urbanization and increasing prices for timber (D) resulted in the least forest land loss. Regardless of the degree of urbanization, increasing timber prices (B, D) functioned to mitigate, but not prevent, the loss of forest. In other words, increasing timber prices—which historically have been due to continued strong, healthy markets for timber—are key to keeping forests forested.

[20] Adapted from Figure 4.9 in Wear and Greis 2013; data in Figure 1-15 are approximated, and bars may not be perfectly to scale.

2 RECOMMENDED CITATION

Jefferies, Hannah M. and Tracy Leslie. 2017. “Historical Perspective on the Relationship between Demand and Forest Productivity in the US South: Executive Summary.” Charlotte, North Carolina, USA: Forest2Market, Inc.

3 REFERENCES

Boyd, William. 2001. "The Forest is the Future? Industrial Forestry and the Southern Pulp and Paper Complex." Pp 168-218 in *The Second Wave: Southern Industrialization from the 1940s to the 1970s*. Philip Scranton, Ed. Athens, GA: The University of Georgia Press.

Carter, Mason C., Robert C. Kellison and R. Scott Wallinger. 2015. *Forestry in the U.S. South: A History*. Baton Rouge, Louisiana: Louisiana State University Press.

Conner, Roger C. and Andrew J. Hartsell. 2002. "Chapter 16: Forest Area and Conditions." In Wear, David N. and John G. Greis, eds. 2002. *Southern Forest Resource Assessment*. Gen. Tech. Rep. SRS-53. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station.

Crafts, Edward C. 1958. "A Summary of the Timber Resource Review." Pp. 1-109 in *Timber Resources for America's Future*. Forest Resources Rep. No. 14. Washington, D.C.: US Department of Agriculture Forest Service.

Fedkiw, John. 1989. "The Evolving Use and Management of the Nation's Forests, Grasslands, Croplands, and Related Resources." Gen. Tech. Report RM-175. Fort Collins, Colorado: US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Food and Agriculture Organization of the United Nations. 2016. Forestry Production and Trade database. http://www.fao.org/faostat/en/#data/FO. Retrieved November 18, 2016.

Forest2Market, Inc. 2015. *Wood Supply Trends in the US South: 1995-2015*. Charlotte, NC: Forest2Market, Inc.

Forest2Market, Inc. 2016. *The Economic Impact of Privately-Owned Forests in the United States*. Charlotte, NC: Forest2Market, Inc.

Fox, Thomas R., Eric J. Jokela and H. Lee Allen. 2004. "Chapter 8: The Evolution of Pine Plantation Silviculture in the Southern United States." In H. Michael Rauscher and Kurt Johnsen, eds. 2004. *Southern Forest Science: Past, Present, and Future*. Gen. Tech. Rep. SRS-75. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station.

Fox, Thomas R., Eric J. Jokela and H. Lee Allen. 2007. "The Development of Pine Plantation Silviculture in the Southern United States." *Journal of Forestry* 105(7): 337-47.

Goetzl, Alberto. 2015. "Developments in the Global Trade of Wood Pellets." Office of Industries Working Paper. Washington, D.C.: US International Trade Commission. https://www.usitc.gov/publications/332/wood_pellets_id-039_final.pdf. Retrieved November 22, 2016.

Hartsell, Andrew J. and Roger C. Conner. 2013. "Forest Area and Conditions: A 2010 Update of Chapter 16 of the Southern Forest Resource Assessment." e-Gen. Tech. Rep. SRS–174. Asheville, NC: US Department of Agriculture Forest Service, Southern Research Station.

Hawkins Wright Ltd. 2016. "Forest Energy Monitor." Issue 66 (September 2016). http://www.forestenergymonitor.com/. Retrieved October 7, 2016.

Hawkins Wright Ltd. 2016. "Forest Energy Monitor." Issue 67 (October 2016). http://www.forestenergymonitor.com/. Retrieved November 8, 2016.

Hewes, Jaketon H., Brett J. Butler, Greg C.Liknes, Mark D.Nelson and Stephanie M. Snyder. 2014. Public and Private Forest Ownership in the Conterminous United States: Distribution of Six Ownership Types - Geospatial Dataset. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2014-0002.

Howard, James L. and Kwameka C Jones. 2016. "U.S. Timber Production, Trade, Consumption, and Price Statistics, 1965-2013." Research Paper, FPL-RP-679. Madison, WI. US Department of Agriculture, Forest Service, Forest Products Laboratory.

National Bureau of Economic Research. N.d. "NBER Chronology." http://www.nber.org/cycles/NBER%20chronology.xlsx. Retrieved December 22, 2016.

Oswalt, Sonja N., Brad W. Smith, Patrick D. Miles and Scott A. Pugh. 2014. *Forest Resources of the United States, 2012: a technical document supporting the Forest Service 2015 update of the RPA Assessment*. Gen. Tech. Rep. WO-91. Washington, DC: US Department of Agriculture, Forest Service, Washington Office.

Prestemon, Jeffrey P. and Robert C. Abt. 2002. "Chapter 13: Timber Products Supply and Demand." In Wear, David N. and John G. Greis, eds. 2002. *Southern Forest Resource Assessment*. Gen. Tech. Rep. SRS-53. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station.

Prestemon, Jeffrey P., David N. Wear and Michaela O. Foster. 2015. "The Global Position of the U.S. Forest Products Industry." e-Gen. Tech. Rep. SRS-204. USDA Forest Service. Asheville, NC: US Department of Agriculture Forest Service, Southern Research Station.

Rettie, James C. and Dwight Hair. 1958. "Future Demand for Timber." Pp. 357-471 in *Timber Resources for America's Future*. Forest Resources Rep. No. 14. Washington, D.C.: US Department of Agriculture Forest Service.

Sheffield, Ray. 2009. "Planted Forests and Plantations." Pp. 67-70 in Smith, W. Brad, Patrick D. Miles, Charles H. Perry and Scott A. Pugh. 2009. *Forest Resources of the United States, 2007*. Gen. Tech. Report WO-78. Washington, DC: US Department of Agriculture, Forest Service, Washington Office.

Smith, W. Brad, Patrick D. Miles, Charles H. Perry and Scott A. Pugh. 2009. *Forest Resources of the United States, 2007*. Gen. Tech. Report WO-78. Washington, DC: US Department of Agriculture, Forest Service, Washington Office.

Stewart, Pete. 2015. "Wood Supply Chronicles, Part 2: The Unintended Consequences of Timberland Divestments." Forest2Market, Inc. https://blog.forest2market.com/wood-supply-chronicles-part-2. Retrieved February 1, 2017.

Stuber, Daniel. 2016. "US South Future Implications Part I: Timber Inventory." Forest2Market, Inc. https://blog.forest2market.com/us-south-future-implications-part1-timber-inventory. Retrieved February 1, 2017.

US Bureau of Economic Analysis. 2016. "Measuring the Economy: A Primer on GDP and the National Income and Product Accounts." http://www.bea.gov/national/pdf/nipa_primer.pdf. Retrieved December 6, 2016.

US Bureau of Economic Analysis. 2016. "Current Dollar and 'Real' GDP." http://www.bea.gov/national/xls/gdplev.xls. Retrieved November 16, 2016.

US Census Bureau. N.d. Housing Starts: Total: New Privately Owned Housing Units Started [HOUST]. FRED, Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/HOUST. Retrieved November 21, 2016.

US Census Bureau. N.d. “Changes in Urbanized Areas from 2000 to 2010.” http://www2.census.gov/geo/docs/reference/ua/PopAreaChngeUA.xls. Retrieved December 13, 2016.

US Census Bureau. N.d. “Characteristics of Units in New Multifamily Buildings Completed: Square Feet.” https://www.census.gov/construction/chars/xls/mfu_squarefeet_cust.xls. Retrieved December 22, 2016.

US Census Bureau. N.d. “Characteristics of New Single-Family Houses Completed: Square Feet.” https://www.census.gov/construction/chars/xls/squarefeet_cust.xls. Retrieved December 22, 2016.

US Census Bureau. N.d. “State Population Estimates and Demographic Components of Change: 1900 to 1990 Total Population Estimates.” https://www.census.gov/popest/data/state/asrh/1980s/80s_st_totals.html. Retrieved November 23, 2016.

US Census Bureau. N.d. “1990s State Tables.” https://www.census.gov/popest/data/historical/1990s/state.html. Retrieved November 23, 2016.

US Census Bureau. N.d. “State Intercensal Estimates (2000-2010).” https://www.census.gov/popest/data/intercensal/state/state2010.html. Retrieved November 23, 2016.

US Census Bureau. N.d. “State Totals: Vintage 2015.” https://www.census.gov/popest/data/state/asrh/2015/index.html. Retrieved November 23, 2016.

US Department of Agriculture. 2015. *2012 National Resources Inventory*. Natural Resources Conservation Service, Washington, DC. http://www.nrcs.usda.gov/Internet/NRCS_RCA/reports/. Retrieved November 22, 2016.

US Department of Agriculture. 2015. *Summary Report: 2012 National Resources Inventory*. Washington, DC: Natural Resources Conservation Service and Ames, IA: Center for Survey Statistics and Methodology, Iowa State University.

USDA Forest Service. 1988. *The South’s Fourth Forest: Alternatives for the Future*. FS-24. Washington, DC. http://www.biodiversitylibrary.org/item/133509. Retrieved December 5, 2016.

USDA Forest Service. 2011. *National Report on Sustainable Forests—2010.* FS-979. Washington, DC.

USDA Forest Service. 2012. *Future of America’s Forest and Rangelands: Forest Service 2010 Resources Planning Act Assessment*. Gen. Tech. Report WO-87. Washington, DC.

USDA Forest Service. 2016. *Future of America's Forests and Rangelands: Update to the 2010 Resources Planning Act Assessment.* Gen. Tech. Report WO-GTR-94. Washington, DC.

Wear, David N. and John G. Greis. 2012. “The Southern Forest Futures Project: Summary Report.” Gen. Tech. Rep. SRS-GTR-168. Asheville, NC: USDA Forest Service, Southern Research Station.

Wear, David N. and John G. Greis, eds. 2013. “The Southern Forest Futures Project: Technical Report.” Gen. Tech. Report SRS-GTR-178. Asheville, NC: USDA-Forest Service, Southern Research Station.

Wear, David N., Douglas R. Carter and Jeffrey Prestemon. 2007. “The U.S. South’s Timber Sector in 2005: A Prospective Analysis of Recent Change.” Gen. Tech. Report SRS-99. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station.

Zhang, Daowei, Brett J. Butler and Rao V. Nagubadi. 2012. “Institutional Timberland Ownership in the US South: Magnitude, Location, Dynamics, and Management.” *Journal of Forestry* 110(7): 355-361. http://dx.doi.org/10.5849/jof.12-015. Retrieved December 5, 2016.