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Trends in Forest Harvest, Regeneration, and Management in the Southeastern United States as Related to Biomass Feedstock

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1.0 Introduction

Woody biomass has received substantial attention as a renewable energy source and, thus, is at the forefront of climate change mitigation policies to help reduce greenhouse gas (GHG) emissions. Wood-based biomass feedstock production in the United States (US) has tripled over the last decade, largely due to European commitments to reduce GHG emissions and reliance on fossil fuels (Masum et al. 2019; Giuntoli et al. 2022). This trajectory is expected to continue as international demand increases, particularly for biomass feedstocks used for power and heat generation, or for industrial applications and other hard-to-abate sectors (i.e., wood for pellets and energy production). Guo et al. (2015) estimated that bioenergy will comprise 30% of the global energy consumption by 2050. There are concerns that increased demand for wood-based bioenergy may lead to forest and biodiversity loss through either increased levels of planted stands and/or harvesting, particularly in the southeastern US, which is a key region for wood pellet production (Olesen et al. 2016; Giuntoli et al. 2022). To better understand potential effects of bioenergy demand on forest resources, NCASI evaluated harvest and regeneration trends and drivers of forest management across the southeastern US as related to potential forest loss. A related publication (NCASI 2022) examined biodiversity response to similar drivers.

The term “biomass” may have different uses in different contexts. Scientifically, biomass refers to the mass of organic material that comes from plants and animals. In a forestry context, biomass therefore usually refers to the dry weight of wood and other plant material. However, in the context of renewable energy from biological materials, biomass may refer to the feedstock of a bioenergy facility. In this briefing note, we use the term “biomass” to refer to the quantity of cellulosic material from forests either measured in forest inventories or converted to forest products. We use the term “biomass feedstock” to refer specifically to feedstocks for facilities that use biological materials from forests for production of fuel, heat, or power.

2.0 Trends in forest harvest and regeneration

We analyzed data from the USDA Forest Service’s Forest Inventory and Analysis (FIA) program to examine recent trends in forest harvest levels and regeneration in the southeastern US (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee,

Texas, and Virginia). We have presented results for a time series covering the most recent consistent forest inventory data (2009-2017) for these states.

In the southeastern US, approximately 5-6 million acres and 160-180 million short tons (Mt) of biomass are harvested for use across the forest products sector annually. Annual state-level harvesting estimates range from 180,000-850,000 acres and 5-30 million short tons. As shown in Figure 1, Alabama, Georgia, and Mississippi have the highest harvesting rates (largely planted softwood). Harvesting, in terms of both acres harvested (Figure 2) and quantity of biomass harvested for all products (Figure 3), declined during 2009-2017. This decrease occurred despite increased production of wood-based products for bioenergy over this same period, as wood pellet production was around 3 Mt/yr in 2009 and increased to a little over 7 Mt/yr in 2017 (Giuntoli et al. 2022).

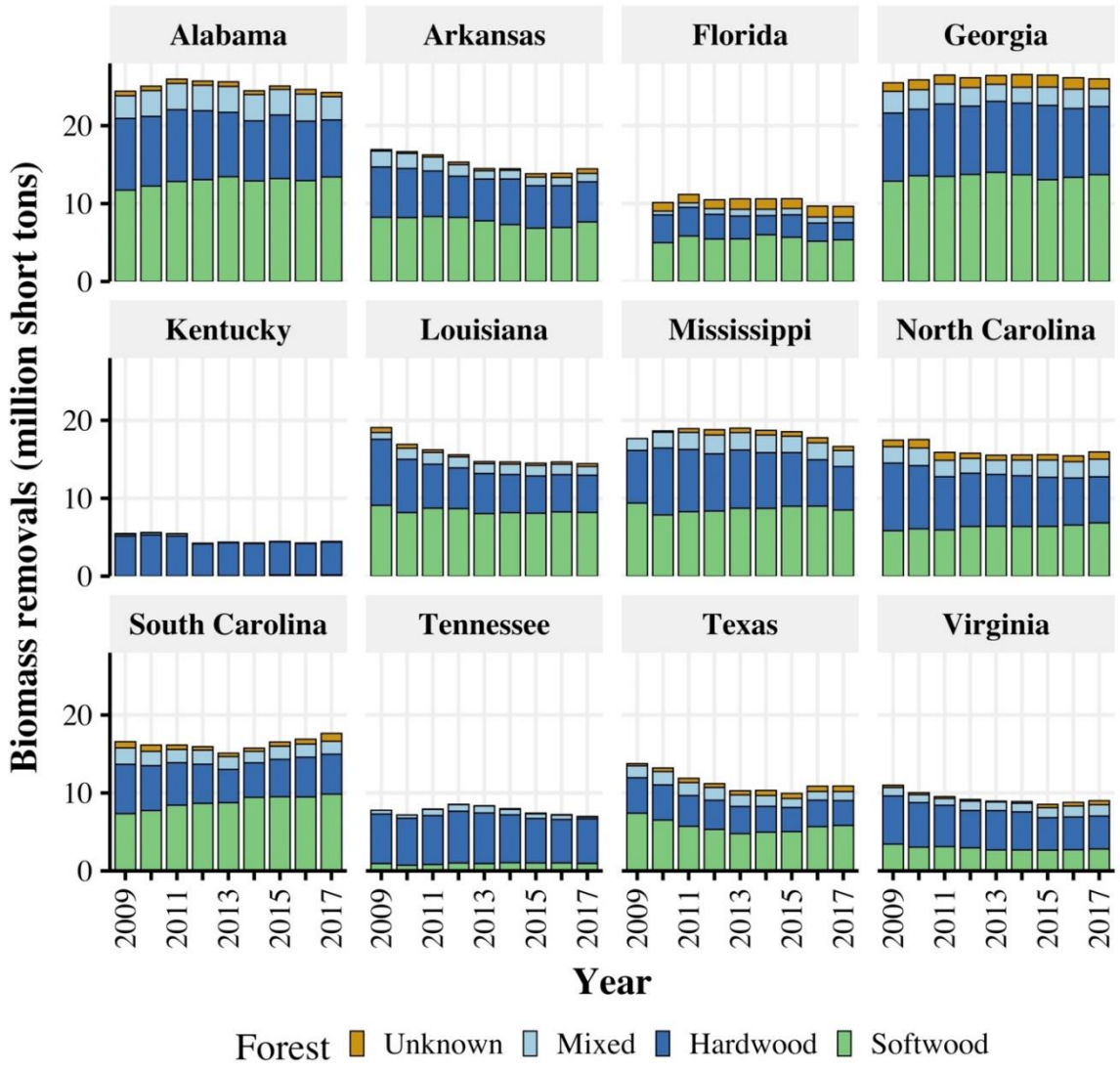

Figure 1. *Annual biomass (million short tons) harvested for all products by state and forest type in the southeastern United States for 2009-2017.*

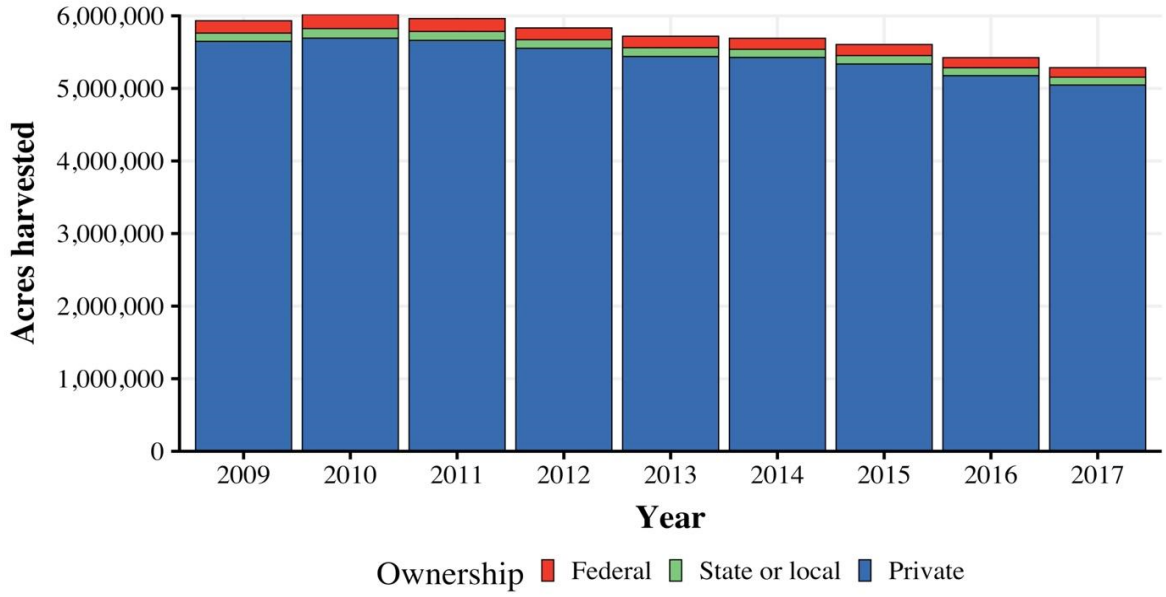

Figure 2. *Annual acres harvested by ownership in the southeastern United States for 2009-2017.*

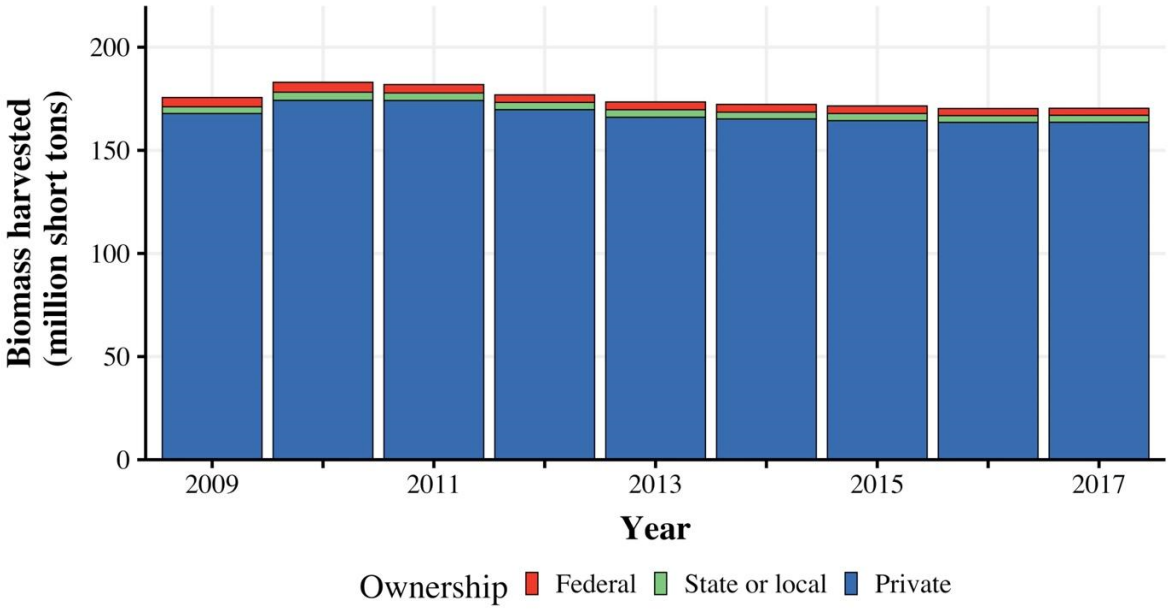

Figure 3. *Aboveground biomass (million short tons) harvested for all products in the southeastern United States for 2009-2017.*

Most harvesting (in terms of area) was partial harvest (64%) rather than clearcut/regeneration harvest (36%), compared in Figure 4. In this context, partial harvest includes commercial thinning, removal of highest quality trees, shelterwood harvest where seed trees are retained, and salvage cutting of dead or damaged trees. Clearcut harvest area in hardwood forests declined by 16% during the study period, while clearcut area in softwood forests increased by 27% (Figure 5), likely due to rebounding demand for softwood lumber following the great recession of 2008. Total clearcut harvest area remained relatively flat over the period.

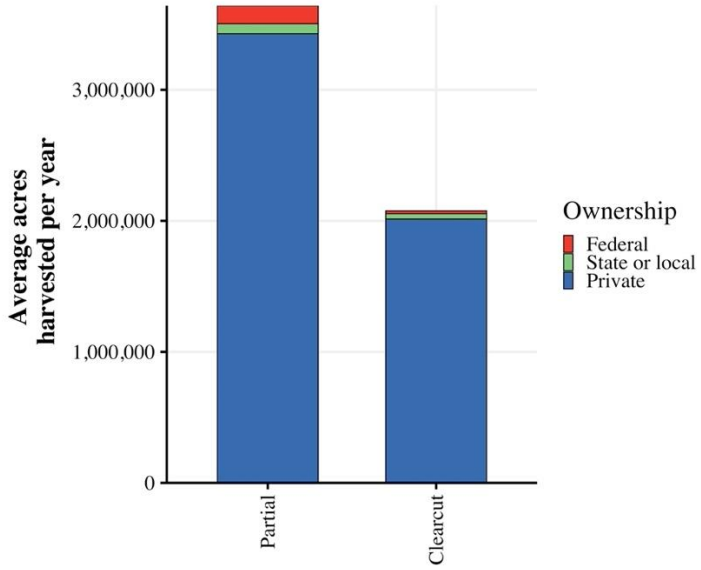

Figure 4. *Average number of acres harvested annually by harvest type (partial and clearcut) and ownership group (federal, state or local, and private) in the southeastern United States for 2009-2017.*

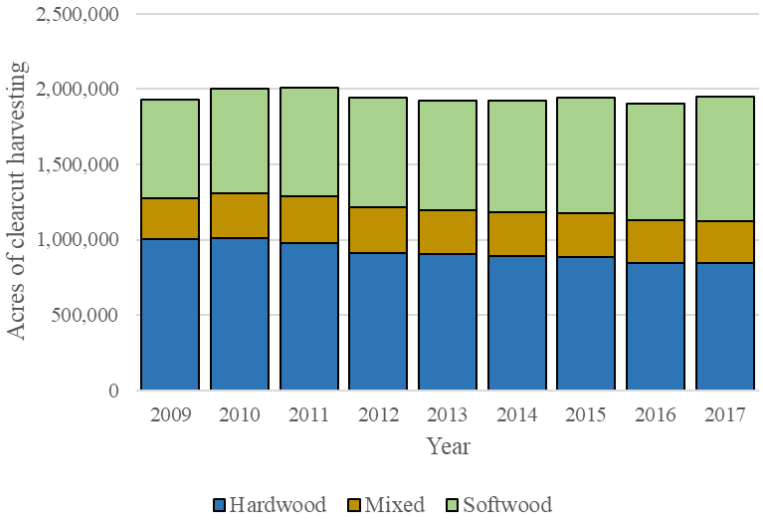

Figure 5. *Area of clearcut harvesting in the southeastern United States by forest type.*

There is no evidence from field measurements of more than 97,000 inventory plots within the southeastern US that there has been net conversion of hardwood forest to pine over the recent inventory remeasurement cycle (Table 1). Total forest area in the southeastern US declined by 1.8 million acres, approximately 1% of the previous forest area. Hardwood types converted to softwood totaled 3.8 million acres, more than offset by softwood types converted to hardwood (3.9 million acres). Additionally, FIA data showed that there are currently more than 110 million acres of hardwood forests across the southeastern U.S. (excluding mixed stands), meaning this hardwood to softwood conversion was approximately 3.4% when considering only prior hardwood acreage (current softwood acreage that were previously hardwoods divided by prior hardwood acreage) and 1.8% when considering total prior forest acreage (current softwood acreage that were previously hardwoods divided by total prior forest acreage). Bottomland hardwood area increased by approximately 1%. Softwood forest types increased by 3%, mostly from mixed pine-hardwood types. Similarly, there is no evidence of an increase in planted forest (Table 2). In fact, planted forest area is estimated to have decreased slightly from 47.5 million acres at the previous inventory to 46.9 million acres currently. While total forest land area in the southeastern US decreased slightly during this period, the forest biomass increased from 9.2 billion short dry tons in 2009 to 10.3 billion tons in 2017, an increase of 12% (USDA 2022).

Table 1. *Southern US forest area by forest type from current and previous Forest Inventory Analysis (FIA) measurements (thousands of acres) in the southeastern United States. Current measurement years are 2018-2021 (varies by state); previous measurement years are 2008-2016.*

		Current forest type (thousand acres)						
		Bottomland hardwood[1]	Upland hardwood	Mixed	Softwood	Temporarily nonstocked[2]	Non-forest	Total
Previous forest type	Bottomland hardwood	28,186	1,906	1,037	561	264	890	32,844
	Upland hardwood	2,350	67,120	4,591	3,239	252	2,680	80,233
	Mixed	725	2,861	10,924	6,487	91	613	21,700
	Softwood	690	3,221	3,745	63,487	927	1,509	73,578
	Temporarily non-stocked	333	255	82	822	585	450	2,527
	Non-forest	989	1,620	396	1,211	167	165,957	170,341
	Total	33,274	76,982	20,775	75,807	2,285	172,099	381,223

[1] Forest types associated with wetter areas: elm-ash-cottonwood and oak-gum-cypress.

[2] Insufficient numbers of trees at time of inventory to determine the eventual forest type.

Table 2. *Southern US forest area by stand origin (natural versus planted) from current and previous Forest Inventory Analysis (FIA) measurements (thousands of acres). Current measurement years are 2018-2021 (varies by state); previous measurement years are 2008-2016.*

Previous stand origin	Current Stand Origin (thousand acres)		
	Natural	Planted	Total
Natural	150,568	6,719	157,286
Planted	7,228	40,225	47,453
Total	157,796	46,944	204,740

3.0 Drivers of forest management

The amount of harvested wood used for biomass feedstock is a minimal portion of total timber harvest in the southeastern US. Wood used for pellet production currently accounts for about 2% of total timber harvest in this region (Brandeis and Abt 2019). Forest harvest decreased over recent years, and increases in demand for biomass feedstock harvest have not increased overall forest harvest to rates from 15 years ago. As illustrated in Figure 6, wood production peaked in 2005, and production declined dramatically during the 2008 recession, with sawtimber products accounting for the largest portion of losses (Hodges et al. 2012). However, production of pulpwood and composite products, which both rely on the same lower-cost, smaller-diameter trees as the biomass feedstock market, has steadily declined since the 2005 forest harvest peak. Even if wood pellet production doubled in the southeastern US, it still would not compensate for the recent decline in production of pulpwood and composite panels, lead to increased levels of harvest of any forest type, or increase rates of conversion to non-forest uses.

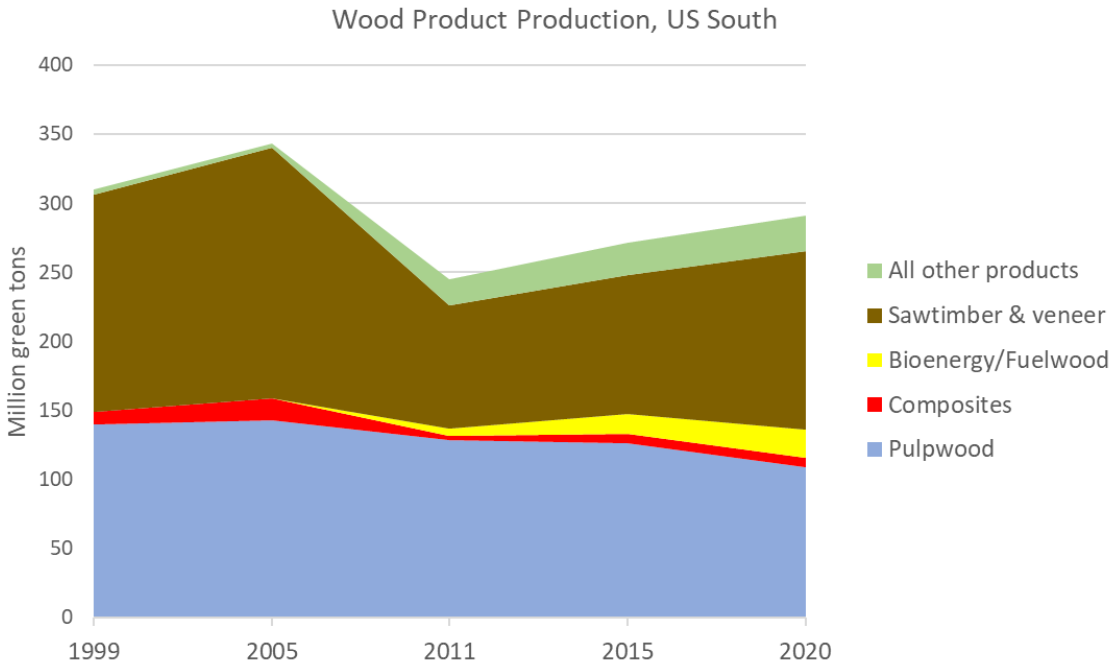

Figure 6. *Wood product production (million green tons) in the southern United States from 1999-2020. Data were obtained from USDA Forest Service Timber Products Output (TPO) program Interactive Reporting Tool: https://public.tableau.com/views/TPOREPORTINGTOOL/MakeSelection?:showVizHome=no*

Prices drive harvest decisions, and biomass feedstock is low-priced material. Prices that landowners receive for their wood have a significant effect on their decision to harvest timber (Zhang et al. 2015; Zhao et al. 2020). This suggests that the market for biomass feedstock could only drive timber harvest decisions if prices offered were high relative to other products. But in the southeastern US, the stumpage price (that landowners are paid) for biomass feedstock is comparable to that for pulpwood. South-wide sawtimber stumpage prices were recently $26/ton for pine and $33/ton for hardwood. At the same time, pulpwood stumpage prices (also relevant to biomass feedstock) were about $11/ton for both pine and hardwood[1]. This indicates that a landowner harvesting a 55-year-old mixed oak-pine stand for biomass feedstock would receive about $1,080 per acre, while the same stand sold for a mix of sawtimber and pulpwood would receive about $2,115 per acre[2].

Furthermore, during the recession of 2009-2014, landowners in the southeastern US responded to plunging prices for sawtimber. The amount of timberland area that was clearcut and replanted dropped 47% since the mid-1980s, while the area undergoing partial harvests such as thinnings increased by 57% (Hodges et al. 2011). This amounted to a decline in clearcut harvest of 5 million acres from 2005-2012. This was driven by sawtimber prices, because during this same period, pulpwood prices remained relatively flat. This further demonstrates forest landowner response to markets and prices.Of added importance, healthy markets for forest products incentivize maintaining forest cover (National Commission on Science for Sustainable Forestry 2005).

4.0 Conclusions

Harvesting rates in the southeastern US have slightly declined and there continues to be a surplus of growth compared to harvest, despite a doubling in wood pellet production between 2009-2017. This surplus of forest growth accommodated increases in biomass production. The southeastern US continues to grow far more timber than is harvested. Annual growth amounts to 681.6 million green tons, while annual harvest totals 390.8 million tons (USDA 2022). This suggests that an additional 290.8 million tons could be harvested before harvest and growth are in equilibrium. In 2015, wood pellet harvest was about 7 million green tons (Brandeis and Abt 2019), indicating that pellet production could increase over 40 times before the growth/harvest equilibrium would be reached.

It is important to understand that the primary driver of forest loss in the southeastern US is conversion due to urbanization (Olson 2020). As indicated above, strong forest products markets encourage maintenance of forest cover by private forest landowners; wood for biomass feedstock is another market that encourages investment in forest resources.

Finally, forest landowners are subject to state and regional forest biomass harvesting guidelines (Titus et al. 2021). Most of these guidelines fall within the context of third-party audited certification programs such as Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC) (Titus et al. 2021). These programs address timber harvesting from the perspectives of both

[1] http://www.timbermart-south.com/prices.html

[2] Based on average pulpwood and sawtimber yield estimates from Smith et al. (2006) for mixed oak-pine stands in US South.

forest landowners and wood purchasers, and have criteria regarding biodiversity conservation, forest land conversion, water quality protection, and other ecosystem services (NCASI 2022).

5.0 References

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