

Brief Communication - harvesting & utilization

# Roundwood Use by Southern Wood Pellet Mills: Findings from Timber Product Output Mill Surveys

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## Abstract

Between 2012 and 2017, southern wood pellet exports grew by approximately 180 percent, whereas the regions' wood pellet mill capacity increased from 3.8 to 7.7 million tons over the same period. This capacity and production growth generates concerns regarding impacts on resource sustainability and to traditional forest industries that use feedstocks similar to those used by pellet mills. Information on wood pellet producers' patterns and levels of roundwood consumption can help evaluate the potential impacts of the industry on the forest resource. We use mill-level data collected by the USDA Forest Service Southern Research Station Forest Inventory and Analysis program to help characterize activity by southern wood pellet mills that consume roundwood. Our analysis shows that the volume of roundwood used for pellet production has increased, representing close to 2 percent of all southern timber products output and 27 percent of all industrial fuelwood output (excluding firewood) during 2015.

**Keywords:** wood pellet mills, bioenergy, roundwood production, timber products output, primary timber products

Wood pellet production has increased over the past few years, with most new capacity supported by increasing demand from European markets (Abt et al. 2014, Olesen et al. 2016). From 2012 to 2017, wood pellet exports from southern ports increased by nearly 180 percent, from 2.06 million tons to 5.7 million tons (US Department of Commerce 2018). Further, at the national level, the industry ranks among the top five forest products exports, with its share of total domestic forest products exports increasing from 3 to 7 percent between 2012 and 2017 (USDA Foreign Agriculture Service 2018). Although wood pellet production in the United States has increased generally, the recent increase in production is focused on utility (bulk) pellet production. Other production in the United States is primarily bagged pellets for residential consumption.

According to the US Department of Energy, Energy Information Administration (EIA) (2019), all utility pellet production in the United States occurs in the South, and according to the US Department of Commerce (2018), all bulk wood pellet exports come from southern ports. This increased southern wood pellet production resulting from a growing mill capacity creates concerns regarding the sustainable use of the forest resource (Evans et al. 2013, Olesen et al. 2016, Cornwall 2017) and increases the competition for low-value roundwood used by traditional industries such as pulp and OSB production (Abt et al. 2012, Skog et al. 2014).

Information collected by EIA (2019) shows pellet production originating primarily from residues (e.g., almost 80 percent of the feedstock coming from

### Management and Policy Implications

The recent increase in the production of utility wood pellets for export has implications for markets for small roundwood and mill residues, both of which are used as inputs in the production of wood pellets. This increased competition can increase the prices of these inputs, and affect other users of both mill residues and roundwood. Therefore, assessing the level of forest resources used by the wood pellet industry is key to evaluating the industry's likely impacts on resource sustainability and ecosystem health. Such data can help inform decisions by stakeholders such as forest landowners, state forestry agencies, and others involved in forest management and resource use.

residues in 2017—29 percent classified as mill residues and 50 percent as other residues). Note that EIA's other residues classification includes wood chips, a portion of which would be considered roundwood (defined as wood in the rough either whole or chipped, aimed for industrial manufacture) if wood chips originate from tree sections rather than mill residues. Therefore, to identify the effect of wood pellet production on forest resources, we need to know actual roundwood consumption by pellet mills. In this paper, we extract data collected by the USDA Forest Service Forest Inventory and Analysis periodic Timber Products Output (TPO) surveys of the primary forest products industry (i.e., all mills using roundwood to generate a primary product such as lumber, veneer, pellets, etc.) at the south-wide level and evaluate the changes in pellet mill roundwood use between 2011 and 2015. Specifically, we characterize the roundwood-using wood pellet industry in terms of volume consumed by major tree species, procurement areas, proportion of total timber outputs that are in wood pellet production, and the share of mill residues from primary wood products industry used by wood pellet mills.

Data collected by TPO are processed and published both through an online database ([https://www.fs.usda.gov/srsfia/php/tpo\\_2009/tpo\\_rpa\\_int1.php](https://www.fs.usda.gov/srsfia/php/tpo_2009/tpo_rpa_int1.php)) and through state and product level reports (e.g., Gray et al. 2017 and Gray et al. 2018, respectively). Because of confidentiality limitations, however, these data have not been analyzed independently for pellet mills. Wood pellet mills using roundwood are still few at the state level, prompting their inclusion under aggregated categories. However, the number of pellet mills included in the TPO survey has grown steadily, from one mill in 2009 to nine mills in 2015, making it possible to report product information for the US South region.

### Data-Collection Methods

The southern TPO survey covers 12 of the 13 states in the Forest Service's Southern Region, namely

Alabama, Arkansas, Georgia, Florida, Kentucky, Louisiana, Oklahoma, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia (Texas does not participate—the state independently conducts a similar mill survey). This paper uses mill-level information for three survey years—2011, 2013, and 2015. Mills report total timber volume consumed by species group and county of origin. Mills are also asked to report volume of residues produced by residue-type (e.g., sawdust, shavings, etc.) and the way in which these residues are used. In general, mills report residues in green tons. Residues reported in dry tons are converted to green tons assuming a 50 percent moisture content. Residue volumes for mills that fail to provide the residue information are calculated by applying estimated residue factors to mill receipts.

While the TPO survey targets the entire population of active primary mills, as shown in Table 1, full response is rarely achieved. Data for nonresponding mills are imputed using information from the mills' latest available response. When an industry is changing rapidly, TPO may also miss some mills (we call these “missing mills”). Prior to the production of utility pellets, most pellet mills used only mill residues

**Table 1.** Response rates across the region by mill type and Timber Products Output survey year.

Mill type	Timber Products Output survey year		
	2011	2013	2015
	(percent)		
Sawmill	74.2	53.2	60.9
Veneer and plywood	80.4	70.8	72.3
Pulp and paper	94.7	72.4	88.2
Composite panel	95.0	77.3	72.7
Wood pellet	100.0	85.7	88.9
Other miscellaneous	85.7	64.1	83.9

*Note:* Other miscellaneous include post, pole, pilings, mulch, and other fuelwood-using mills.

as feedstock (Forisk 2018). Spelter and Toth (2009) list 26 wood pellets mills operating within our study area by end of 2009, with TPO identifying four mills using roundwood in 2011.

We note that the 2013 and 2015 TPO surveys had a few missing mills that likely consumed roundwood (Table 2). Although statistics and analyses provided within this paper center on data collected by TPO, as a reference point, we also estimate total roundwood consumption for 2015 (Table 3), by assuming the four mills not surveyed in 2015 used only roundwood and worked at full capacity during their respective operating months. Thus, these estimates provide an upper bound value for 2015 roundwood consumption. Although in Table 3 we identified each missing mill and its estimated consumption, we cannot provide similar information for the nine pellet mills in the 2015 TPO survey because of confidentiality concerns. We provide roundwood consumption only in aggregate south-wide (i.e., across the 12 southern states in the TPO survey). Wood pellet mills captured by TPO included those producing industrial and residential pellet grades.

**Table 2.** Number of roundwood-using wood pellet mills by Timber Products Output survey year.

Survey year	Using roundwood	In Timber Products Output survey	Missing mills
2011	4	4	0
2013	8	7	1
2015	13	9	4

Note: Wood pellet mills surveyed by Timber Products Output located across six states: Alabama, Florida, Georgia, Mississippi, North Carolina, and Virginia.

**Table 3.** Estimated roundwood consumption including assumed volumes for missed mills, 2015.

Mill name	State	Annual capacity	Months operating	Roundwood*
		(tons)	(number)	(green tons)
Morehouse BioEnergy	Louisiana	496,000	4	363,733
Amite BioEnergy	Mississippi	500,000	4	366,667
Enviva Pellets Northampton	North Carolina	550,000	12	1,210,000
Zilkha Biomass	Alabama	303,000	9	499,950
Missed mills total				2,440,350
Mills in Timber Products Output survey		3,845,000	12	4,482,403
Southern estimated total				6,922,753

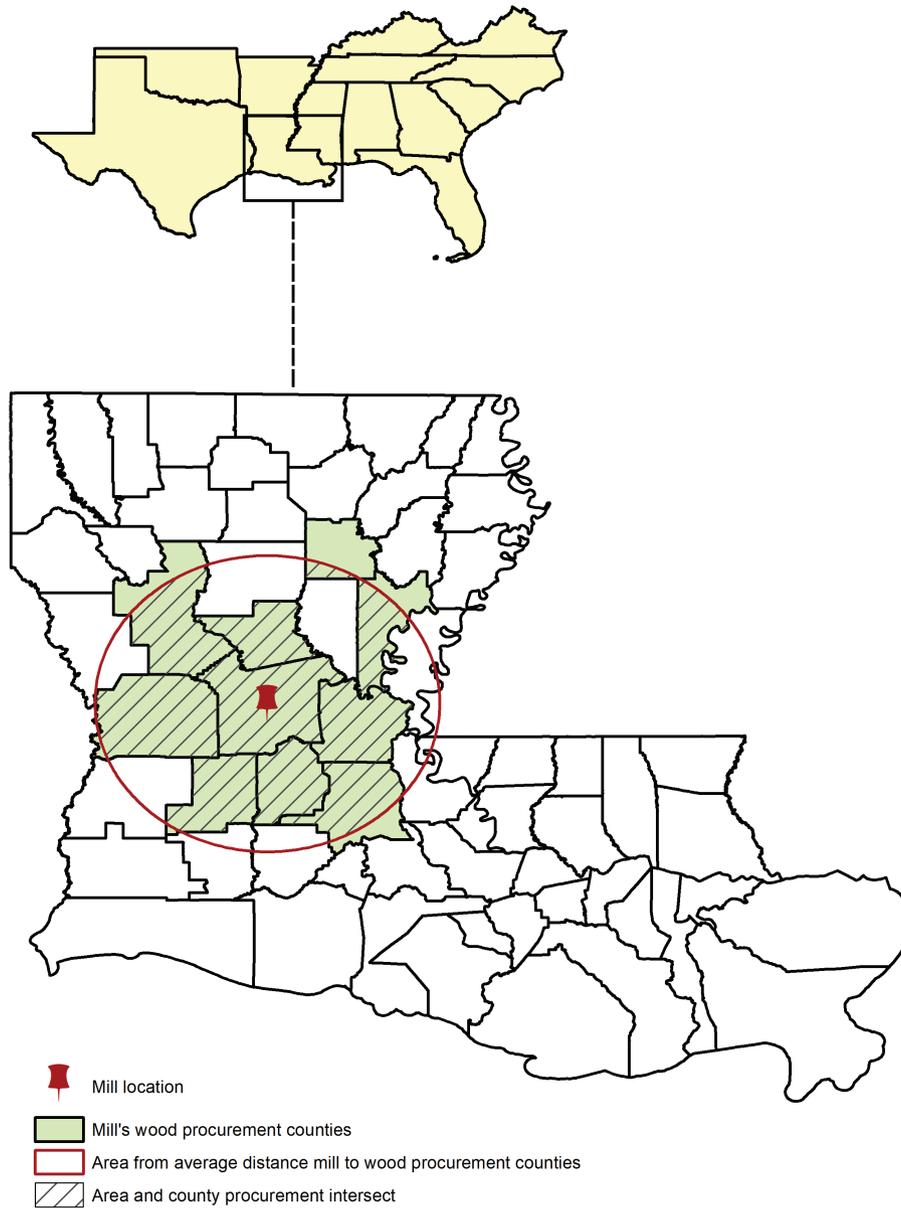
\* Roundwood for missed mills assumed from full capacity during operating months and 100 percent roundwood use (1 ton of pellets = 2.2 green tons of roundwood). Roundwood for mills in Timber Products Output survey is based on reported amounts.

Information on county of origin for roundwood received was used along with mill location to estimate mean and median procurement distances. Distance from mill  $i$  to supplying county  $j$  corresponds to the Euclidean distance between the points representing location of mill  $i$  and centroid of county  $j$ . Using the Euclidean distance provides an easy way to estimate distances. However, the method introduces measurement error, as travel routes rarely conform to straight lines. Research comparing road and Euclidean distances finds a high correlation between the two, with correlation declining with distance (Boscoe et al. 2012, Buczkowska et al. 2016). Similarly, allocating all county volume to the county centroid facilitates estimation, but assumes that harvests are equally distributed across a county. Although the assumption introduces error, it provides an alternative for estimation when exact harvest locations are unknown. As a way to examine the strength of our calculated distances, we used ArcGIS 10.3 buffer and intersect tools (ESRI 2015) to determine, for each mill, the percentage of volume falling within the area encompassed by the estimated average procurement distance (or procurement radius) as illustrated in Figure 1. Results were aggregated to generate regional mean and median values.

## Results

Table 4 summarizes our wood procurement distance estimates by survey year. We note an increase in the average mean (median) distances, from 37 (35) miles in the 2011 survey to 54 (41) miles in the 2015 survey. Plotting procurement volume by procurement distance (Figure 2) shows larger distances corresponding with smaller wood volumes.

As shown in Figure 3, the volume of roundwood used for wood pellet production increased from 1.8



**Figure 1.** Simulated Louisiana mill and its county procurement area intersected with the area encompassed by the estimated average procurement distance.

million tons in 2011 to nearly 4.5 million tons in 2015 (or 6.9 million tons under the assumptions for the missing mills presented in Table 3). Wood pellets accounted for a small percentage of the total timber use south-wide, with its share increasing from less than 1 percent in 2011 to almost 2 percent in 2015 (Figure 4). Southern industrial fuelwood (excluding firewood) more than tripled between 2011 and 2015, increasing from almost 5.5 to 16.7 million tons (Figure 5). Wood pellet mills comprised 34 and 27 percent of the total industrial fuelwood use in 2011 and 2015, respectively.

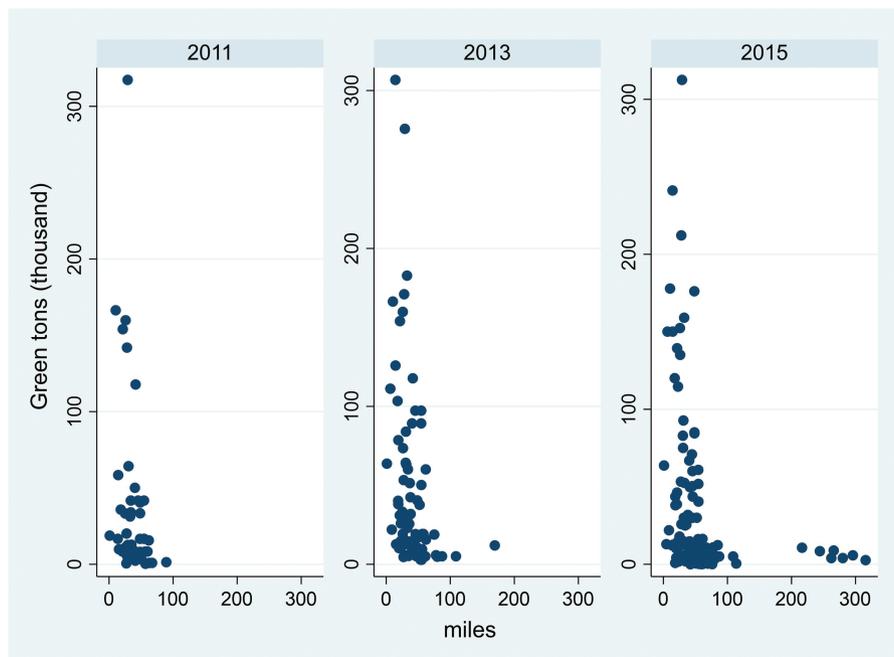
Focusing on the group of counties supplying roundwood to pellet mills (i.e., procurement areas) shows

wood pellet mills representing close to 9 percent of all roundwood volume in both the 2011 and 2015 procurement areas (47 and 111 counties south-wide, respectively; Figure 6). Pulpwood and saw logs were the two primary products in the 2011 and 2015 procurement areas, accounting for approximately 77 percent of the total roundwood output.

The volume of mill residues generated by primary forest products mills increased by 7 percent between 2011 and 2015, from 47.29 to 50.69 million green tons (Table 5). Mill residues sold to wood pellet mills increased from less than 0.5 million in 2011 to 2.3 million green tons in 2015. Primary mills supplying

**Table 4.** Summary statistics for estimated procurement distances.

Timber Products Output year	Mill count	Distance from mill to county centroid (miles)				
		Mean	Median	SD	Min	Max
2011	4	37.3	34.9	17.1	1.0	89.4
2013	7	39.2	35.3	23.1	1.0	169.5
2015	9	53.7	41.2	56.2	1.0	315.7



**Figure 2.** Wood pellet mills roundwood volumes by procurement distance, 2011–15.

residues for wood pellet production increased from 23 to 83 mill between 2011 and 2015, respectively. These primary mills were located in states that held at least one in-state pellet mill (considering all wood pellet mills, regardless of feedstock). Unused residue remained under 1 percent of total residue production, with volume increasing from nearly 0.2 million to 0.4 million green tons.

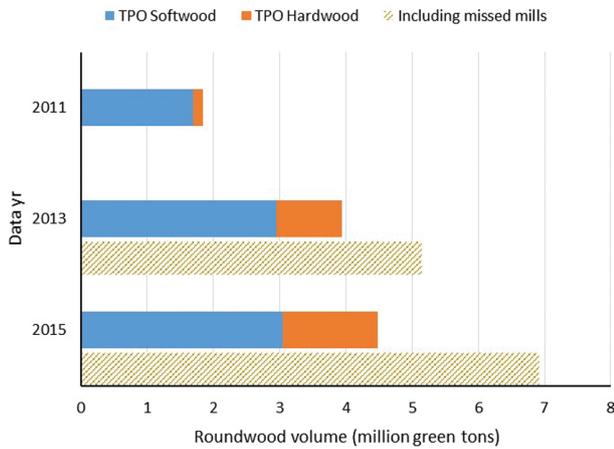
**Discussion**

As expected, the number of counties (south-wide) from which wood pellet mills procured roundwood increased with the rise in the number of operating mills. In 2011, the four wood pellet mills using roundwood received wood from 47 counties. By 2015, the nine pellet mills in the TPO survey procured wood from 111 counties. The increase in number of operating mills resulted in higher interstate wood flow, reflected in larger procurement distances. Maximum procurement distance

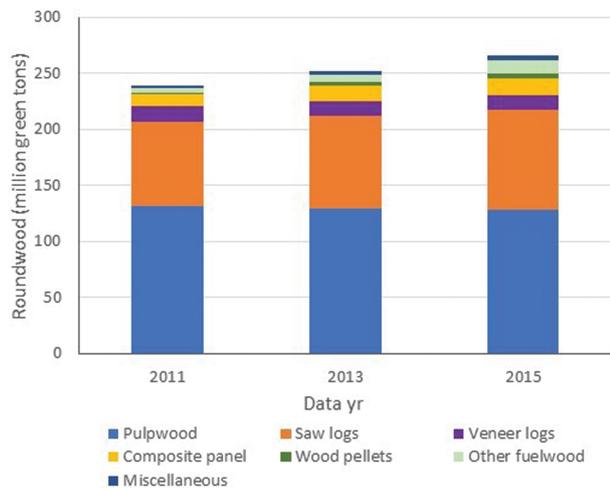
increased, from 89 miles in 2011 to over 300 miles in 2015. Although our distances are approximations, we find them to provide acceptable estimates, with areas generated by our estimated procurement radius capturing over 90 percent of the mills’ volume in 2011 and 85 percent of the 2015 volume.

Softwood species comprised the predominant group used by wood pellet mills in all three surveys, yet the proportion of hardwoods increased from nearly 8 percent in 2011 to 32 percent in 2015. This increase in hardwood consumption could simply reflect the feedstock available to the added mill capacity.

Wood pellet mills represented less than 2 percent of the region’s total roundwood output in 2015. However, industrial fuelwood, which includes wood pellets and other fuelwood (excepting firewood), accounted for 6 percent of the 2015 roundwood production, surpassing both veneer and composite panel volumes. The observed growth in roundwood fuelwood consumption resulted mostly from other fuelwood-using mills



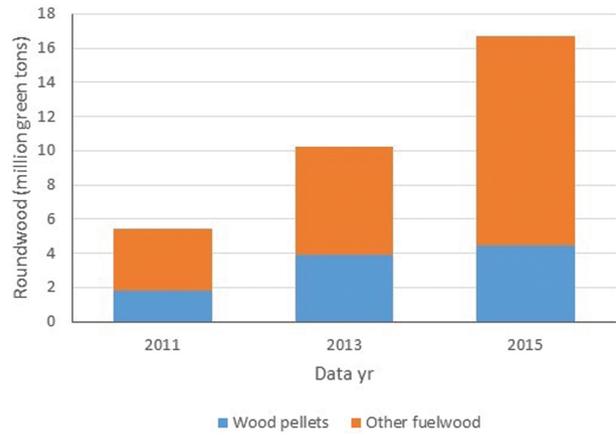
**Figure 3.** Timber Products Output volume of roundwood used by pellet mills by major species group and total estimated roundwood volume including assumed volume for missed mills, 2011–15.



**Figure 4.** Southern Timber Products Output volume by primary product, 2011–15. Miscellaneous includes posts, poles, pilings, and mulch mills.

rather than wood pellet producers. Other consumers of fuelwood included pulp and paper mills, veneer and plywood mills, and other miscellaneous mills.

These results differ when we evaluate only the counties from which wood pellet mills reported procuring roundwood in each survey year. In these procurement areas, sawmills and pulp and paper mills remain the top consumers, but wood pellet mills follow in third place in all survey years. Additionally, wood pellet mills appear as the primary fuelwood consumer, unlike the pattern observed at the regional scale. Because of the varying number of mills and the increased size of the area examined each survey year, however, we cannot draw inferences from the changes in allocation percentages across time. Those changes could be



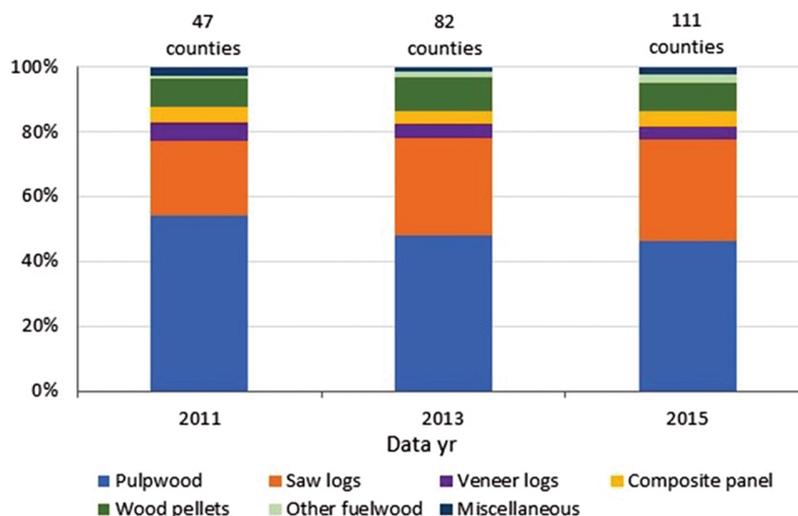
**Figure 5.** Volume of roundwood fuelwood (excluding firewood) used across the Southern Timber Products Output region, 2011–15.

originating from shifts in markets or resulting from the expanded area of analysis. For instance, Figure 5 shows a larger share of fuelwood consumed by other mill types in 2015 compared to 2011. This percentage increase could be a reflection of the larger area providing wood pellets in 2015, which results in more interaction across mill types (more procurement overlapping), or it could indicate added demand from other roundwood fuelwood consumers, or a mixture of both.

In terms of residues from primary mills, we observe an increase in residue volumes between 2011 and 2015, with the volume sold to wood pellet production increasing as well, from nearly 1 percent to 5 percent of the 2011 and 2015 total mill residues, respectively. Volumes used as on-site industrial fuel and mulch/soil additives declined steadily. However, on-site industrial fuel remained the second highest use of mill residues, accounting for 21 percent of all residues. Fiber/composite products remained the main use, consuming 53 percent of the 2015 residue.

### Summary and Conclusions

Mill data from the TPO survey serve to further characterize activity by the wood pellet industry, including identifying broad patterns of roundwood consumption and describing the use of residue from other primary mills. Although the 2015 TPO survey captured only 78 percent of the total estimated capacity of roundwood-using pellet mills (Table 3), the information still helps place pellet production in perspective. We note that whereas the volume of pellets exported from southern ports (excluding Texas) increased by nearly 130 percent between 2012 and 2015 (US Department of



**Figure 6.** Percentage distribution of roundwood consumption across primary products within the set of wood pellet procuring counties corresponding to each Timber Products Output survey year, 2011–15. Miscellaneous includes post, poles, pilings, and mulch.

**Table 5.** Mill residue volume (excluding bark) distribution across various reported by-product uses, 2011–15.

By-product type	2011	2013	2015
	(million green tons)		
Animal bedding	1.17	1.25	1.71
Wood pellets	0.42	1.36	2.33
Industrial fuel at other plants	2.99	4.69	5.54
Industrial fuel at this plant (on-site)	13.39	11.14	10.47
Fiber/composite products mfg.	26.12	25.01	26.99
Mulch/soil additive (includes biochar)	1.04	0.73	0.64
Small dimension and other sawn products	0.37	0.56	0.28
Other miscellaneous*	1.58	1.90	2.32
Not used (land fill, burned as waste)	0.19	0.23	0.41
<b>Total</b>	<b>47.29</b>	<b>46.87</b>	<b>50.69</b>

\* Charcoal or chemical wood, other fuelwood-using mills, and other miscellaneous uses

Commerce 2018), the product accounted for only 1.7 percent of the Southern total output volume in 2015 (or 2.6 percent if including missed mills estimates shown in Table 3).

TPO survey data also reveal wood pellet production taking a 27 percent share of the total roundwood consumed for fuelwood within the southern TPO region in 2015 (34 and 39 percent in 2011 and 2013,

respectively). We do not know, however, whether the type of roundwood consumed by pellet mill producers is of a different quality and type than that consumed by other fuelwood consumers (e.g., do pellet mill producers use more lower grade roundwood than other fuelwood-using mills?) While capturing information on quality of roundwood is beyond the scope of the TPO survey, such information could help us evaluate the impact of pellet production on forest resources. Increased use of previously nonmerchantable portions of harvested trees, as well as increased use of lower-quality roundwood, could translate into better returns for landowners at time of harvest and also, in the future, result in fewer trees of poor quality left in the stand. Harvest utilization studies, such as Wall et al. (2018), with a focus on harvests in pellet mill procurement regions could prove valuable in this area.

The importance of pellet mill residue demands in the primary mill residues market has increased as well, providing an additional residue market for primary mills. Future TPO survey data will clarify trends in mill residues use, allowing further evaluation of impacts on primary mills residue markets. Additionally, the sensitivity of the wood pellet industry to changes in mill residue availability and extent of shifts in mill residue use could be explored as more TPO data become available. A shift in mill residue use from on-site fuel use to wood pellets, for instance, could have implications for energy portfolios at the local level as mills shift from on-site energy production to other energy sources.

Analysis shows a tendency to larger procurement distances with an increasing number of pellet mills (larger mean and median distances in 2015 compared to 2011). As the area supplying wood for pellet production increases, so does the expected competition with other mills procuring similar materials, such as low grade and/or small logs. Procurement effects could thus be transmitted to neighboring areas as other mills adjust their procurement. Research using TPO survey data to evaluate effects of changes likely motivated by this interaction across pulp and pellet mills is currently under way.

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## Literature Cited

- Abt, K.L., R. Abt, and C. Galik. 2012. Effect of bioenergy demands and supply response on markets, carbon and land use. *For. Sci.* 58(5):523–539.
- Abt, K.L., R.C. Abt, C.S. Galik, and K.E. Skog. 2014. *Effect of policies on pellet production and forests in the US South: A technical document supporting the Forest Service update of the 2010 RPA Assessment*. USDA Forest Service Gen. Tech. Rep. SRS-202, Southern Research Station, Asheville, NC. 33 p.
- Boscoe, F.P., K.A. Henry, and M.S. Zdeb. 2012. A nationwide comparison of driving distance versus straight-line distance to hospitals. *Prof. Geogr.* 64(2):188–196.
- Buczowska, S., N. Coulombel, and M. De Lapparent. 2016. Euclidean versus network distance in business location: A probabilistic mixture of Hurdle–Poisson models. *Hal Archives-Ouvertes*. doi: 10.13140/RG.2.1.4875.6241. Available online at <https://hal.archives-ouvertes.fr/hal-01377757v2>; last accessed March 15, 2019.
- Cornwall, W. 2017. Is wood a green source of energy? Scientists are divided. *Science* 355(6320):18–21.
- ESRI (Environmental Systems Research Institute). 2015. *ArcGIS desktop: Release 10.3.4*. Environmental Systems Research Institute, Environmental Systems Research Institute, Redlands, CA.
- Evans, A.M., R.T. Perschel, and B.A. Kittler. 2013. Overview of forest biomass harvesting guidelines. *J. Sustain. Forest.* 32(1–2):89–107.
- Forisk, Inc. 2018. *Q1 2018 Forisk Research Quarterly Bioenergy Database [subscription database]*.
- Gray, J.A., J.W. Bentley, J.A. Cooper, and D.J. Wall. 2017. *Virginia's timber industry—timber product output and use, 2013*. e-Science Update SRS-114. USDA Forest Service, Southern Research Station, Asheville, NC. 4 p. Available online at <http://treesearch.fs.fed.us/pubs/54861>; last accessed July 13, 2018.
- Gray, J.A., J.W. Bentley, J.A. Cooper, and D.J. Wall. 2018. *Southern pulpwood production, 2016*. e-Resour. Bull. SRS-222. USDA Forest Service, Southern Research Station, Asheville, NC. 15 p. Available online at <https://www.fs.usda.gov/treesearch/pubs/56531>; last accessed March 30, 2019.
- Olesen, A.S., S.L. Bager, B. Kittler, W. Price, and F. Aguilar. 2016. *Environmental implications of increased reliance of the EU on biomass from the South East US*. European Commission Report ENV.B.1/ETU/2014/0043. European Commission, Luxembourg. 357 p. Available online at <http://www.aebiom.org/wp-content/uploads/2016/08/DGENVI-study-imports-from-US-Final-report-July-2016.pdf>; last accessed August 3, 2018.
- Skog, K.E., R.C. Abt, and K.L. Abt. 2014. Chapter 6: Wood energy and competing wood product markets. P. 338 in *Wood energy in developed economies: Resource management, economics and policy*, Aguilar, F.X. (ed.). Routledge, New York.
- Spelter, H., and D. Toth. 2009. *North America's wood pellet sector*. Research Paper FPL-RP-656. USDA Forest Service, Forest Products Laboratory, Madison, WI. 21 p. Available online at <https://www.fs.usda.gov/treesearch/pubs/35060>; last accessed May 17, 2019.
- USDA Foreign Agriculture Service. 2018. *Global agricultural trade system (GATS) database*. Available online at <https://apps.fas.usda.gov/GATS/default.aspx>; last accessed March 8, 2018.
- US Department of Commerce. 2018. *Trade policy information system (TPIS) database*. Available online at <http://tpis1.trade.gov/cgi-bin/wtpis/prod/tpis.cgi>; last accessed March 8, 2018.
- US Department of Energy, Energy Information Administration. 2018. *Monthly densified biomass fuel report: Table 3. Feedstocks and average cost per ton for the manufacture of densified biomass products, 2017*. Available online at [https://www.eia.gov/biofuels/biomass/#table\\_data](https://www.eia.gov/biofuels/biomass/#table_data); last accessed April 9, 2019.
- Wall, D.J., J.W. Bentley, J.A. Gray, and J.A. Cooper. 2018. *Georgia harvest and utilization study, 2015*. e-Resource Bulletin SRS-217. USDA Forest Service, Southern Research Station, Asheville, NC. 23 p. Available online at <https://www.fs.usda.gov/treesearch/pubs/56048>; last accessed May 17, 2019.