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To: Tyson Miller, Sam Davis, Dogwood Alliance
From: Spencer Phillips
Date: 4/27/2016
Subject: Acreage required to meet projected biomass pellet demand from the European Union, 2016 - 2030

The purpose of this memo is to provide an answer to the question "How many acres of forestland in the US Coastal South are required to produce the tonnage of wood pellets projected for export to Europe for biomass energy production?"

Due to the long-term nature of forest management, there are two acreages that comprise the answer. The first is how many acres need to be harvested in a given year to produce the amount of wood pellets for export to Europe in that year. The second is the number of acres that need to be under management at a given point in time so that there will be sufficient fiber volume available for future harvests to meet future export demand.

The first of these calculations is fairly straightforward and is:

$$Harvest\ (Acres)_t = \frac{\left[(\text{dry tonnes Pellet Exports}_t) \times \left(\frac{\text{green tons furnish}}{\text{dry tonnes pellets}}\right)\right] - [\text{green tons residue}]}{\text{harvest yield}\ (\text{green tons biomass / acre})}$$

This numerator combines metric tons (tonnes) export demand in year *t* with a furnish-to-pellet conversion factor to yield the number of short tons of furnish needed. From this amount, we subtract the share of total furnish that comes from mill and logging residues. (We assume that this share will hold at its current level of 24%.) This leaves green tons of biomass that will come directly from forest harvest. Dividing required biomass harvest (in tons) by the yield rate (in tons per acre) gives the number of acres that must be harvested in year *t* to meet that year's pellet export demand.

The second calculation would be simple if the value of exports were to remain constant over time. In that case we would take the number of acres that have to be harvested to produce one year's worth of pellets for export and multiply that number by the number of years between harvest. So for a 25-year rotation, we multiply by 25; for a 50-year rotation, we multiply by 50.

What makes this more complicated is that exports from the U.S. south are expected to grow over time, from about 3.9 million metric tons (mmt) in 2014 to 10.6 mmt in 2019 more than 15 million mt in 2030 (Walker et al. 2015). Beyond 2019, and based on a low estimate from Abt et al. (2014), we estimate that exports from the US south to the EU would rise to 31.5 mmt in 2030. (We assume that demand will remain constant at that level after 2030.)

Given projected increases in the supply of pellets, the number of acres managed to supply pellet manufacturing will have to increase as well. If all forestland is managed so that harvest can be accomplished on a 25 year rotation, for example, then the number of acres under that management regime in 2016 would be the number of acres that would need to be harvested in 2016 plus the number

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of acres that will need to be harvested to meet the increased demand in each of the years 2017 through 2041.

Naturally, not every acre is going to be managed in the same way and have the same yield, and the allocation of forestland to different (i.e. more- or less-productive) management regimes will affect the total number of acres needed. In Table 1, below, we provide one sample scenario in which 24% of pellet furnish comes from logging and mill residues (Walker et al. 2015), and the remainder comes from forest management. Length of rotation and harvest volume for these forest/management types are derived from *The 2005 RPA Timber Assessment Update* (Haynes et al. 2007).

Table 1: Growth Rate, Rotation, Harvest, and Allocation to Management Regime	**Annual Growth**	**Rotation**	**Harvest**	**Sample Allocation to Management Regime**
Management Type	**green tons / acre / year**	**years**	**green tons**	**% of all pellet-fuel source acres**
Planted Pine	4.0	25	100	**38%**
Natural Pine	2.0	45	**91**	**20%**
Mixed Hardwood & Pine	1.5	50	**77**	**13%**
Hardwoods (lowland & upland)	1.6	55	86	**5%**
Residues				**24%**

Source: Haynes, Richard W., Darius M. Adams, Ralph J. Alig, Peter J. Ince, John R. Mills, and Xiaoping Zhou. 2007. *The 2005 RPA Timber Assessment Update*. General Technical Report PNW-GTR-699. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Many thanks to John Mills for supplying data for the South from the RPA Assessment and to Samantha Davis for calculating rotation and harvest from those data.

Further assumptions for this scenario are:

- Pulpwood can be converted to pellets at a rate of 2.24 green tons of pulpwood per dry metric ton of pellets
- Pulpwood growth per acre per year, rotation age, and tons harvested at the end of the rotation are provided in Table 1.
- We assume that there are sufficient acres already under the various management regimes at the beginning of the period (in 2014).

Based on projected pellet demand and these assumptions regarding per-acre productivity and rotation length and the sample allocation given in Table 1, European demand for pellet fuel would require that 73,336 acres be harvested to produce sufficient pulpwood feedstock to pellet meet export demand in 2016. These harvested acres are among the 8.7 million acres that need to be in the pellet fuel pipeline in

order to meet projected future demand. By 2030, when pellet exports from the U.S. Coastal south are expected to be 31.5 mmt (requiring 74.1 million green tons of furnish), some 280,011 acres will need to be harvested. In order to sustain that level of export into the future, 10.5 million acres will need to be continuously managed for pellet fuel feedstock.

Year-by-year estimates for this scenario are depicted in Figures 1 and 2, below. Details for 2016 and 2030 are provided in Table 2. The "Biomass Acreage Estimator" spreadsheet allows for the creation of additional scenarios involving different assumptions regarding export volume and allocation of land to management regimes.

Figure 1: Annual Harvest to meet Current Export Demand, by Management Type, 2014-2030

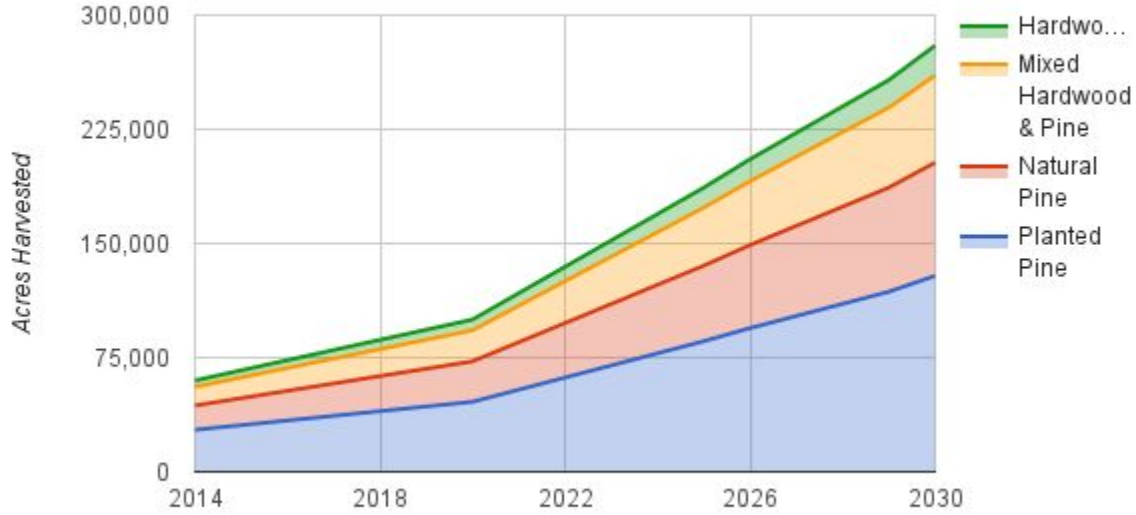

Figure 2: Acres Managed to Meet Current and Future Export Demand, by Management Type, 2014-2030

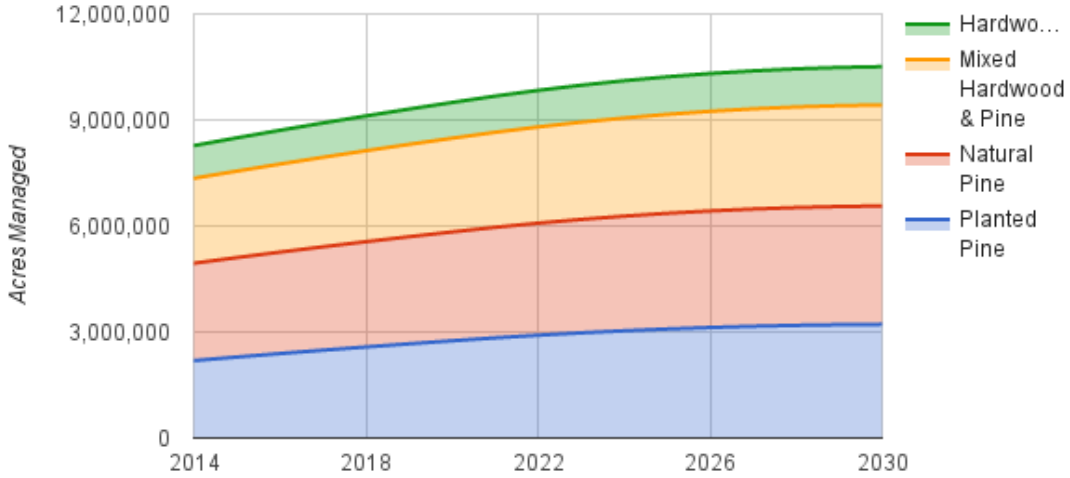

Table 2: Scenario Results		2016		2030	
	Allocation	Harvested	*Managed*	Harvested	*Managed*
Total	**100%**	**73,336**	***8,707,864***	**280,011**	***10,509,266***
Planted Pine	**38%**	**33,708**	***2,389,557***	**128,701**	***3,217,536***
Natural Pine	**20%**	**19,495**	***2,870,784***	**74,437**	***3,349,662***
Mixed Hardwood & Pine	**13%**	**14,976**	***2,491,190***	**57,181**	***2,859,055***
Hardwoods (lowland & upland)	**5%**	**5,157**	***956,334***	**19,691**	***1,083,014***
Residues	**24%**				

References

Abt, Karen L., Robert C. Abt, Christopher Galik, and Kenneth E. Skog. (2014) "Effect of Policies on Pellet Production and Forests in the U.S. South: A Technical Document Supporting the Forest Service Update of the 2010 RPA Assessment." General Technical Report. Research Triangle Park, NC: USDA Forest Service: Southern Research Station, December. http://www.srs.fs.usda.gov/pubs/gtr/gtr_srs202.pdf.

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Walker, Seth, Chris Lyddan, William Perritt, and Pilla, Lori. 2015. "An Analysis of UK Biomass Power Policy, US South Pellet Production and Impacts on Wood Fiber Markets: Prepared for the American Forest & Paper Association." Boston: RISI. www.risi.com.