1. Abt, Karen Lee et al. ***Effect of Policies on Pellet Production and Forests in the U.S. South, United States Department of Agriculture*****, US Forest Service Southern Research Station, December 2014.**

Conclusion/Findings: The authors assess forests in the US South and project future forest supply trends that show that increased bioenergy production will lead to increased forest inventory and forest cover in the US South.

Considerations:

- Market Effects: Considers the impact of increased markets on forest inventory and landowner decisions.
- Assumptions:
  - Acknowledges the use of lower-value fiber as feedstock for bioenergy.
  - Recognizes the positive impact of increased markets on forest inventory.

Summary: By acknowledging the positive role that markets play in forest health, this study finds that increased markets for forest products will lead to increased forest inventory. Though this study does not directly assess forest carbon, an increase in forest inventory will positively impact forest carbon stock.

2. Dale, Virginia et al. *Ecological objectives can be achieved with wood-derived bioenergy*, The Ecological Society of America, 2015.

Conclusions/Findings: This analysis finds that as demand for wood increases, so does wooded area in the US.

Considerations:

- Market Effects: Reflects an understanding of the positive impact of increased market opportunities on forest cover.
- Time Scale: Acknowledges that, based upon the prevailing science, long-term, cumulative emissions are harmful to our environment and are correlated to increased atmospheric temperatures.[1]

Summary: By considering the role that markets play in forest landowner management and harvesting decisions, this paper finds that increased demand for wood leads to increased forested area. This has been true in the US since the 1950s. Additionally, forest carbon stocks have remained relatively stable in the US despite increased development and population growth. This report states that carbon assessments should be carried out on a long-term basis and should consider the complexities of the US forest market.

[1] Intergovernmental Panel on Climate Change (IPCC). *Climate change 2013:The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, et al. (eds.), 2013.

3. Dale, V., K. Kline et al. *Status and prospects for renewable energy using wood pellet from the southeastern United States.* GCB Bioenergy, 2017.

Conclusion/Findings: The authors research how the production of wood pellets in the US South is affecting forest systems and find, by reviewing current forest conditions and sustainability systems in place, that wood pellets are a small fraction of overall forestry operations in the US and can be produced while maintaining or improving forest ecosystems.

Considerations:

- Market Effects:
  - Recognizes the strong history of working forests and private landownership in the US South and that strong demand for forest products makes forested land more valuable and encourage landowners to replant and maintain their forests.
  - Notes that overall forest stocks in the US South have increased for the last 50 years and will continue increasing if conversion to non-forest uses is low.
  - States that the presence of forest markets, including bioenergy, increase the economic attractiveness of forestry, which supports maintenance and expansion of forested lands and their carbon sink capacity.
- Spatial Scale: Uses a regional scale for assessing carbon and greenhouse gases, providing a more complete assessment than a tract-level scale.
- Time Scale: Acknowledges that, based upon the prevailing science, long-term, cumulative emissions are harmful to our environment and are correlated to increased atmospheric temperatures.[2]
- Assumptions:
  - Recognizes that wood removals for pellet production is a tiny fraction of overall harvest removals in the US South.
  - Recognizes that the biggest threat to loss of forested land and carbon stocks is population growth, income-driven urbanization, and a greater projected economic attractiveness of agricultural products as compared to timber products – NOT from production of biomass or any other forest product.
  - Notes that any remaining old-growth forests in the US South are almost exclusively located in protected areas where logging is prohibited.

Summary: Through a thorough understanding of the history of forest resources and the current forest landscape in the US South, the study finds that current levels of wood pellet production in the US South have the potential to improve forest conditions and ecosystems and that forest products will need to remain strong to prevent further conversion of forest land to non-forest uses.

[2] Intergovernmental Panel on Climate Change (IPCC). *Climate change 2013:The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, et al. (eds.), 2013.

4. Dale, V., E. Parish, et al. ***How is wood-based pellet production affecting forest conditions in the southeastern United States?*** **Journal of Forest Ecology and Management 396, pp 143-149. March 2017.**

Conclusions/Findings: The authors analyzed US Forest Service Forest and Inventory Analysis data from 2002-2014 to examine the effects of the pellet industry on forest conditions near Cheasapeake, Virginia and Savannah, Georgia. The authors find through this analysis that timberland volume and carbon pools have seen increases in recent years in both areas.

Considerations:

- Assumptions:
  - Recognizes that wood removals for pellet production is a tiny fraction of overall harvest removals in the US South.
  - Recognizes that the biggest threat to loss of forested land and carbon stocks is urbanization – NOT production of biomass or any other forest product.
  - Recognizes the use of thinnings and residues for bioenergy production, not sawtimber.
  - Recognizes that there are limited alternative markets for lower-value fiber and that often this wood fiber is burned or left on the forest floor after a sawtimber harvest.
  - Acknowledges that bioenergy markets are not driving harvesting decisions.

Summary: By analyzing the data routinely collected by the US Forest Service, this study found that both areas show increasing timberland area, timberland volume, and carbon stocks over the past 6 years. Neither area shows a decrease in timberland volume or area.

5. Galik, Christopher S. & Abt, Robert C., *Sustainability guidelines and forest market response: an assessment of European Union pellet demand in the southeastern United States*, GCB Bioenergy, May 27, 2015.

Conclusions/Findings: This research finds that, regardless of sustainability policies, an increase in forest area and annual gains in carbon is seen from increased bioenergy demand.

Considerations:

- Market Effects:
  - Uses a sub-regional timber supply model, an econometric model using FIA (U.S. Forest Service Forest Inventory and Analysis) data and acknowledging fiber prices and market demands.
  - Considers how forest markets respond to new market entrants in the short-term and mid-term.
- Spatial Scale: Acknowledges that a harvest or tract-level analysis of carbon is incomplete and a regional view is necessary to fully assess carbon stock.
- Assumptions:
  - Recognizes the use of lower-value fiber as feedstock for bioenergy.
  - Accurately assesses pellet demand as having incremental, not exponential, growth post-2014.

Summary: By analyzing market responses to changes in supply and demand and considering historical and projected wood fiber prices in the US South, this study recognizes the positive impact that new markets for lower-value wood fiber can have on forest growth and carbon storage.

6. Hanssen, S., A. Duden, M. Junginger, et al. ***Wood pellets, what else? Greenhouse gas parity times of European electricity from wood pellets produced in the south-eastern United States using different softwood feedstocks.*** **GCB Bioenergy, December 2016,**

Conclusion/Findings: The authors analyze the carbon impact of various feedstocks for bioenergy production in the US South and find a carbon parity of 0-6 years when bioenergy is produced from commercial thinnings, harvest residues, or mill residues.

Considerations:

- Time Scale: Acknowledges that, based upon the prevailing science, long-term, cumulative emissions are harmful to our environment and are correlated to increased atmospheric temperatures.[3]
- Assumptions: Considers alternative market fates of various feedstocks, recognizing that in most cases, wood used for bioenergy production is harvested as part of a sawtimber harvest or as part of a sustainable forest management practices for sawtimber production.

Summary: By calculating carbon benefits using realistic counterfactual scenarios where bioenergy feedstocks are sold into another market or are left to decay in the forest, this study finds that greenhouse gas benefits from using biomass to produce electricity are seen very quickly.

[3] Intergovernmental Panel on Climate Change (IPCC). *Climate change 2013:The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, et al. (eds.), 2013.

7. Miner, Reid et al. *Forest Carbon Accounting Considerations in US Bioenergy Policy*, Journal of Forestry, 112 (6): 591-606, November 2014.

Conclusions/Findings: This study analyzes previous peer-reviewed research on biogenic carbon and considers bioenergy policies that will promote forest growth and increased carbon stocks.

Considerations:

- Market Effects:
  - Considers investments made in forestland as a result of increased markets for forest products.
  - Considers market incentives for replanting and keeping land in forest production.
- Time Scale: Recommends a 100-year time horizon for assessing biogenic carbon. This time horizon is used to assess other greenhouse gas sources and reflects the prevailing science that shows long-term, cumulative emissions are harmful to our environment and are correlated to increased atmospheric temperatures.[4]
- Assumptions:
  - Recognizes the use of thinnings and residues for bioenergy production, not sawtimber.
  - Recognizes that there are limited alternative markets for lower-value fiber and that often this wood fiber is burned or left on the forest floor after a sawtimber harvest.
  - Acknowledges that bioenergy markets are not driving harvesting decisions.

Summary: This analysis finds four research insights which are important to assessing forest carbon. If these insights are used, a net reduction in greenhouse gas emissions is seen from the use of bioenergy in place of fossil fuels:

1) As long as wood-producing land remains forested, wood products and bioenergy reduce fossil fuel use and its long-term carbon emission impacts.
2) Increased demand for wood can trigger investments and increase forest area and forest productivity.
3) Long-term, cumulative CO_2 emissions are correlated with negative environmental effects.
4) A 100 year time-frame should be used to assess biogenic carbon.

[4] Intergovernmental Panel on Climate Change (IPCC). *Climate change 2013:The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, et al. (eds.), 2013.

8. Wang, Weiwei et al., *Carbon savings with transatlantic trade in pellets: accounting for market-driven effects.* Environ. Res. Letters, November, 2015.

Conclusion/Findings: Across different scenarios of high and low pellet demand, the authors found that the greenhouse gas intensity of pellet-based electricity is 74-85% lower than that of coal-based electricity.

Considerations:

- Market Effects: Considers the market effects with a multi-market equilibrium model for assessing greenhouse gases.
- Spatial Scale: Uses a regional scale for assessing carbon and greenhouse gases, providing a more complete assessment than a tract-level scale.
- Time Scale: Acknowledges that, based upon the prevailing science, long-term, cumulative emissions are harmful to our environment and are correlated to increased atmospheric temperatures.[5]
- Assumptions: Recognizes the use of pulpwood or residues as feedstock for bioenergy.

Summary: By recognizing the use of lower-value pulpwood and residues as feedstocks for bioenergy production, this study finds real carbon savings when using biomass from the US in place of coal to produce electricity.

[5] Intergovernmental Panel on Climate Change (IPCC). *Climate change 2013:The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, et al. (eds.), 2013.

9. Woodall, C.W. ***An Assessment of the Downturn of the Forest Products Industry in the Northern Region of the United States*****, US Forest Service Northern Research Station, 2012.**

Conclusions/Findings: This study assesses the forest products industry in the US as a whole and finds that new markets for forest products can assist in filling the gaps created by the Great Recession and the global decline of paper demand.

Considerations:

- Market Effects:
  - Discusses how important a market for lower-value fiber, such as small roundwood is for the health of the forest. These removals allow remaining trees to grow stronger and healthier, making them more attractive for the sawtimber market.
  - Recognizes how a change in one market can impact the entire forest value chain.
- Assumptions: Recognizes that sawtimber-quality wood cannot be used for bioenergy because of its high cost.

Summary: By analyzing the entire forest products market, this study sees that new markets for forest products are needed to continue incentivizing forest landowners to keep their lands forested. While this paper does not directly address carbon, it does address how markets can increase forest cover, thereby impacting carbon storage.