

A Developing Bioenergy Market and Its Implications on Forests and Forest Products Markets in the United States

Executive Summary of research performed by:

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As society explores increasing interest in alternative energy sources, particularly sources that are renewable, important questions arise concerning the economic and ecological impact of these alternative energy sources. Currently these policy questions are manifested as renewable portfolio standards in many developed countries around the world. These standards, if enacted, generally advocate for some percentage of energy production be generated from recognized renewable sources such as solar, wind, and biomass. Using biomass as a raw materials source in energy production has long been a tradition in many industries that utilize such materials in their manufacturing process – an example is the generation of electricity from wood biomass at pulp and paper mills. As these renewable portfolio standards are adopted, emerging markets for these raw materials develop as new bioenergy plants become reality. Whether it is the use of sugarcane, corn, switchgrass, or wood as a raw materials source, these emerging raw materials markets will impact traditional industries currently utilizing these raw materials along with the landscapes where such raw materials are produced.

Interest in renewable energy has historically been associated with increasing energy prices – primarily oil. Individual State renewable energy portfolio standards (RPS) and federal renewable fuel standards (RFS) have generally included woody biomass as a possible feedstock, but have varying definitions of qualifying raw materials. Most studies focused on the sustainability of woody biomass for energy have evaluated the use of residuals from logging and manufacturing (Perlack et al. 2005; Gan and Smith 2007). If woody biomass for energy is limited to logging residuals and other wood waste streams, the amount of energy that can be produced will be limited by the production level of the traditional forest products industry (Galik et al. 2009), and the impact on the timber resource will be minimal. If woody biomass for use in energy production can utilize traditional timber products – particularly pulpwood, then the possible demand for energy will impact the traditional forest products industry (who may have to pay higher raw materials prices) and forest landowners (who may receive higher timber prices). Additionally, the sustainability of the timber resource may be impacted based upon the eventual development of a wood-to-energy industry. Several researchers have discussed the possible ramifications of the legislation and regulation currently under consideration (Campbell, 2009; Bracmort and Gorte 2009).

With increasing discussion of carbon's role in global climate change, there are also important policy question about using woody biomass as an energy source. Carbon accounting methodologies have traditionally recognized the differences in using fossil fuels versus renewable resources in energy generation. More recently, researchers have questioned the carbon accounting methodologies relative to properly assessing the impact of woody biomass on atmospheric carbon dioxide levels. However, it is clear that with increased volatility of oil prices that the United States has a primary interest in reducing its dependence in offshore oil as an energy source. These issues and the ensuing discussion have greatly increased the interest in woody biomass as a feedstock for energy production.

The Forest Resources of the United States

The United States has over 500 million forested acres in the lower 48 states (USDA, Forest Resources of the United States, 2007). However, it is important to recognize that these acres differ substantially by region, ownership, productivity, and forest type. Since the beginning of the 1900s forest area in the United States has been relatively unchanged. The Northern region has expanded acreage over this period while other regions of the

United States have been constant. In recent times losses due to development and urbanization have been offset by marginal agricultural lands returning to forest, particularly in the Southern region.

Forest ownership differs substantially by region with eastern regions having substantially more private ownership and Western regions with more public ownership. The South with over 200 million acres of forestland is about 88% private ownership, the North has 164 million acres of forestland with 77% owned by private entities, the Rocky Mountain region has 71 million acres of forestland with 27% owned in the private category, and the Pacific Coast has 75 million acres with roughly 42% private ownership.

Almost 20% of all forestland is owned and managed by the Federal Government as National Forests. Other agencies such as the Bureau of Land Management and the Department of Defense manage approximately 12% of the United States' forests. State ownership of forestland is about 10% of the United States' forests. Private forestland owners comprise the single largest ownership group in the United States with 38% ownership.

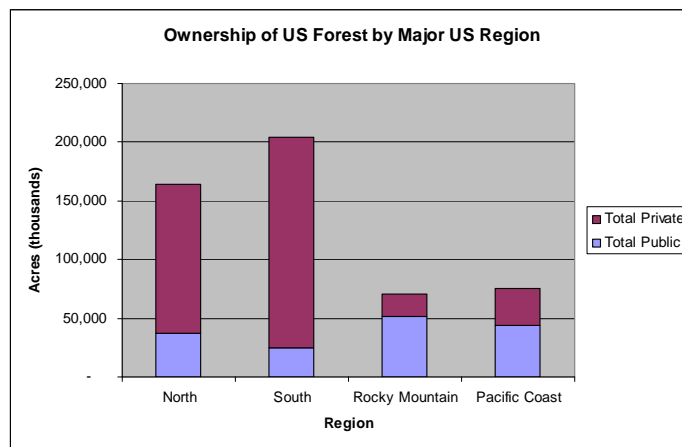


Figure 1

The preponderance of forests in the United States are naturally regenerated (almost 90%) with the remainder in plantations – primarily in the South. The South has almost 50 million acres of softwood plantations (23% of the Southern forests) – the largest installed base of plantations in the world. The Pacific Coast has 12 million acres of softwood plantations (16% of the Pacific Coast forest) followed by the North with almost 6 million acres of plantations (4% of the Northern forests). Hence, woody biomass production from forests across the United States will primarily depend upon materials grown and harvested in natural forests even in the South given the current configuration of forest types in the United States.

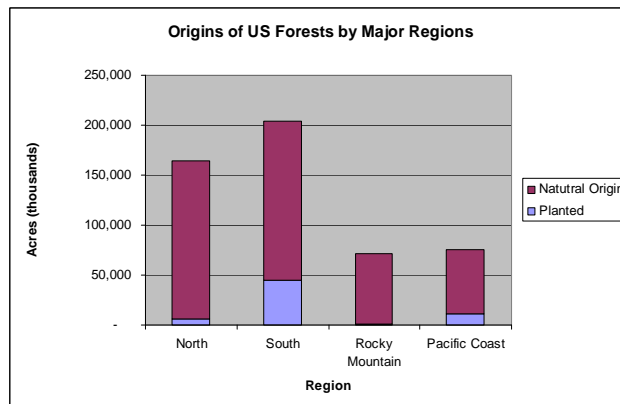


Figure 2

Southern forests exhibit the highest levels of forest productivity with the Rocky Mountains exhibiting the lowest. Most of the highest productivity lands are located west of the Cascade Mountains of the Pacific Coast region or in the South. These two areas have 18 and 39 million acres respectively of high productivity forests. The Pacific Coast forests vary greatly depending upon individual site type and location due to substantial changes in precipitation and inherent site productivity.

The United States timber inventory is almost one trillion cubic feet with approximately 28% of that occurring in the Southern region. The North and the Pacific Coast regions each contain approximately 250 billion cubic feet followed by the Rocky Mountains with 140 billion cubic feet of inventory. Of this total 92% is classified as growing stock volume and the remainder is in live cull trees generally unsuitable for industrial uses. The eastern United States contains the majority of the hardwood growing stock equally divided between the North and the South (about 170 billion cubic feet in each region). The Pacific Coast region contains over 200 billion cubic feet of softwood growing stock followed by the South and the Rocky Mountains with about 110 billion cubic feet of softwood growing stock each. Primary softwood species are Douglas Fir (125 billion cubic feet), loblolly and shortleaf pines in the South (84 billion cubic feet), and true firs with 53 billion cubic feet. Hardwood species of primary importance are oaks with 125 billion cubic feet and maples with about 64 billion cubic feet.

Growing stock volumes are distributed quite unequally among ownerships in the United States. National forests have about 31 percent of all growing stock volume but represent only about 19 percent of the timberland acres. Private timberland owners account for about 58 percent of the growing stock volume on about 70 percent of the timberland acres. Due to the differences in private timberland ownership by region, most of the hardwood and softwood growing stock on private owners is concentrated in the eastern United States. Growing stock volumes have been increasing in recent times according to the United States Forest Service Forest Inventory and Analysis data with an 11 percent between 1997 and 2007 – the most recent remeasurement interval.

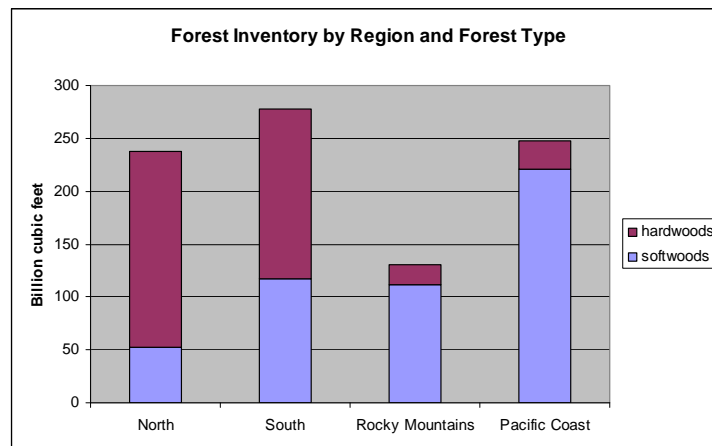


Figure 3

As outlined above, the timber resources of the United States are large and varied – substantial regional and ownership differences make quantification of them difficult above a local wood basket resolution. However, when assessing the resource base available to support a new bioenergy / biofuels industry it is important to recognize that these resource questions will be driven by local wood resources attributes. There are several important observations that will impact the development of woody biomass markets based upon the timber resources of the United States. These include:

- Woody biomass opportunities will follow raw materials resource availability. While obvious, it is important to recognize that plants and industry growth will be focus where the raw materials are plentiful and inexpensive. This will favor the South and Pacific Coast regions.

- National Forest harvest policy will impact the opportunities available in the western United States due to ownership trends.
- With increases in growth to removals ratios due to reduced removals from the current economic recession, there are increasing amounts of raw materials available in all regions for use in a bioenergy industry. In some regions where small tree removals are needed to enhance forest health and decrease fire risk, a developing bioenergy market will improve net growth and forest health by reducing mortality.

Forest Landowner Responses to Increasing Timber Prices

A primary question when considering woody biomass as a feedstock in bioenergy production is the extent to which forest landowners can respond to increasing demand for small trees. Over the past 15 years demand for small trees dedicated to pulp and paper manufacturing has dropped . . . along with the price for those trees. With the closure of over 40 pulp mills in the United States and the downsizing of many more facilities, pulpwood/pulplog demand and consequently price has dropped significantly. For instance, pine pulpwood prices in South Georgia were \$15.50 in 1995 and today that price is \$7.75. Other raw forest products have experienced similar stumpage price trends. As prices have fallen so has the investment in tree growing technology to enhance forest productivity. Today, most industrial forestland owners have reduced their investment due to both declining stumpage prices and increasing forest costs. Midrotation treatments, site preparation treatments, herbaceous weed control, and midrotation woody release are employed more judiciously than in the 1990s when stumpage prices were higher and treatment costs were lower. Similarly, lower planting densities in plantations have become commonplace to reduce costs and produce larger diameter trees over a shorter rotation age – at a sacrifice of increased total biomass production. One probable response to an emerging woody biomass market that includes pulpwood as a possible raw materials source will be increased demand and ultimately higher pulpwood prices for forest landowners. These higher stumpage prices influence forest investment and forest management intensity, particularly in softwood plantations.

Such trends have been apparent in several instances in operational forest management decisions. For instance, in the Lake States oriented strand board (OSB) production facilities were established starting in 1984 using aspen pulpwood as the primary raw material. As demand for aspen increased dramatically as new facilities were built aspen prices also increased (figure 6). One response to these increased prices was to increase the establishment of aspen stands in the Lake States. Over the course of several years aspen prices stabilized as increased supplies became available due primarily to forest landowner response to increased stumpage price. Similar trends have been identified with pine CNS stumpage prices and landowner behavior in the Southeast United States.

A growing woody biomass-to-energy market will increase the demand for pulpwood sized material if that material is included in renewable energy policies. Given the inelasticity of pulpwood supply in the short run, most expect such market expansions to provide upward pressure on pulpwood price. In areas of the United States where increased forest management intensity can be used to impact supply there are opportunities for landowners to respond to such price expectations through increased forest investment, higher realized returns, and ultimately a healthy woody biomass-to-energy industry. These are the expected trends on private lands in the South and Pacific Coast regions where such opportunities will be the greatest due to availability of biomass and the forests to support increased production.

Timber Supply, Demand and Stumpage Price Simulation

Timber supply modeling and simulations of timber supply, demand, and price have been conducted by many researchers over the past 50 years. Since 1958 the U.S. Forest Service has developed periodic assessments of national timber supply and demand to aid in policy discussion and formulation. The early efforts employed historical data along with projected harvest and inventory to perform a “gap” analysis between future timber supplies and future timber demand (USDA Forest Service 1958, 1965, and 1974). In 1974 the Federal Government enacted the Renewable Resource Planning Act (RPA) requiring the United States Forest Service to

develop timber assessments every 10 years with five year interim updates. The RPA process provided interest in and support for better econometric theory and use of FIA data in the modeling process and ultimately led to the development and use of empirical national and regional timber supply and demand projections (Adams and Haynes 1980). The TAMM / ATLAS model framework provided a basis for future national and regional timber supply / demand modeling approaches. This approach was a substantial improvement over the previous “gap” analysis approach but required estimates of timber demand and price elasticities.

During development of the South’s Fourth Forest (USDA Forest Service 1988), the Subregional Timber Supply (SRTS) model was developed to disaggregate the RPA model demands to the FIA survey units across the South. Subsequently, additional inventory modeling drawn from approaches employed by Cabbage et al. (1990) was added to the SRTS model. This approach projected timber inventory using area, growth, and removals for Forest Inventory and Analysis (FIA) data by forest management type. SRTS incorporated this inventory projection model into a timber market model framework in order to project inventory, removals, and price based on theoretical supply and demand interactions, for a single product for two species groups – total volume for softwoods and hardwoods.

The SRTS model was eventually enhanced to the multi-product framework, which differentiates growing stock into individual products. This model has the ability to define separate products by species group and diameter class. Each diameter class is assumed to have a proportion of pulpwood and for larger size classes a proportion of a solidwood product. Solidwood products can be broken down into small sawtimber and large sawtimber. These definitions are used to subdivide aggregate growing stock inventory into product categories. On the demand side, the model utilizes as many demand elasticities as there are defined products. For each product, the supply-price and supply-inventory elasticities are required for each owner category.

A number of simulation efforts using these models to evaluate landowner response to increased demand for raw forest products have been performed. The first significant effort was by Hayes in the 1989 RPA timber assessment. In this work USFS RPA analysts devised a series of high demand scenarios and provided opportunities for substantially increased growth rates in plantation acres of forest industry and naturally regenerated timberlands. These simulations documented the possible impacts of private landowner responses to increasing demand and ultimately stumpage price. Through increased plantation acres and increased growth rates these simulations depicted that the nation’s private forests could provide the additional raw materials to meet the increased demand through increased forest investment spurred by higher prices for raw forest products.

The stumpage supply elasticities used in TAMM and SRTS modeling efforts indicate inelastic response to price changes. TAMM applied different stumpage elasticities for subregions (SE and SC), owners (private and industry) and species groups (hardwoods and softwoods). TAMM softwood supply elasticities for the U.S. South ranged from 0.193 to 0.321 and hardwood elasticities ranged from 0.407 to 0.509. SRTS applied a uniform stumpage supply elasticity value for all categories of 0.300. Both models applied the same unitary inventory supply elasticity. Hence the view today is that short-run elasticities are quite inelastic while longer-run (greater than 5 years) are less so. Such observation is primarily based upon the general belief that private landowners do modify their investment behavior, and ultimately forest productivity, based upon expectations of future markets and dynamic stumpage prices.

In a recent paper Abt et al. (2009) assess the use of woody biomass for energy production using the SRTS model. They take the current policy and regulatory situation and apply it to the possible use of logging residuals and pulpwood to assess possible impacts on timber supply, demand, and price. The discussions of current regulatory issues around woody biomass are found in Campbell (2009) and Bracmort and Gorte (2009). Most recent work on woody biomass harvests have not generally included standing timber as a possible source for woody biomass due to the early definitions of what may qualify under renewable energy policies. Abt et al. used varying levels of residuals utilizations along with standing timber to simulate the impact of wood-to energy under a variety of assumptions relative to timber markets, bioenergy demands, and buy-out price. The woody biomass demand

scenarios are based upon the work of Creech et al. (2009) which assume that wood can contribute 5 percent of the total energy demand by 2015. Additionally, they assumed that there were some significant reductions in the short run due to the current recession. The analysis further assumed that woody biomass will contribute approximately 30 % of the total biomass in the renewable portfolios. The actual contribution depends on the interaction of the projected price increases for wood feedstocks and whether policy allows utilities to buy renewable credits at a set price if feedstock prices become prohibitive.

Results from the Abt et al. (2009) study indicate that relatively small changes in assumptions regarding residuals utilization may have a large impact on the future forest resource as assessed by forest inventory, age class distributions, and movements among stand types. Higher demand scenarios for woody biomass lead to larger impact on the forest resource. As residuals utilization increased the impacts on the resource were somewhat mitigated and smaller increases in prices and removals were a result. While this approach allowed for market responses through the additional planting of more plantations as forest inventories decreased and product prices increased, it does not allow for increased growth in stands due to increased forest investment. Hence, the impacts of an emerging wood-to-energy market on the forest resource may be overstated relative to what may actually occur if these markets develop as expected. We are aware of no analysis that accounts for the forest investment landowner response to these emerging markets.

To assess the possible impacts of increased growth rates we start with the same set of assumptions and input data from the Abt et al. (2009) article. We assume that through increased forest management intensity that corporate (timber companies, TIMOs, REITS) timberland owners will increase growth rates 150 percent over the 30 year time horizon of the simulation NIPF timberlands are assumed to increase 75 percent over the simulation time horizon. These assumptions are consistent with forest productivity research conducted on pine plantations in the South. All other assumptions are consistent with the Abt et al. (2009) article. Further we assumed a relatively low recovery of woody biomass residuals (33%) and the high biomass ramp-up scenario described in the Abt et al. research.

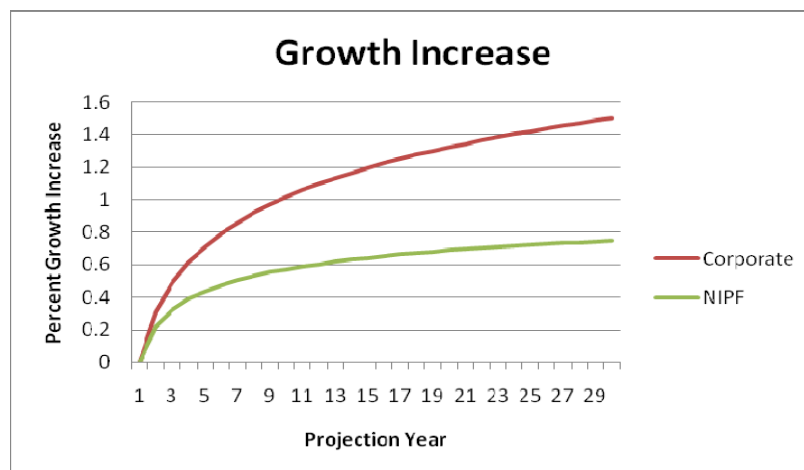


Figure 4. Percent growth increase for corporate and NIPF plantations for each year of the simulation.

The results of the simulations for pine pulpwood and pine sawtimber are depicted in Figures 5 through 10. Figures 5 and 6 describe timber inventory, removals, and price for pine pulpwood (Figure 5) and pine sawtimber (Figure 6). This scenario is the baseline assuming no demand increase due to emerging woody biomass-to-energy markets. Figures 7 and 8 represent the same products assuming the emergence of the wood-to-energy markets. Figures 9 and 10 depict the two products with both increased demand and the inclusion of increased growth rates on corporate and NIPF ownerships in the South as described above.

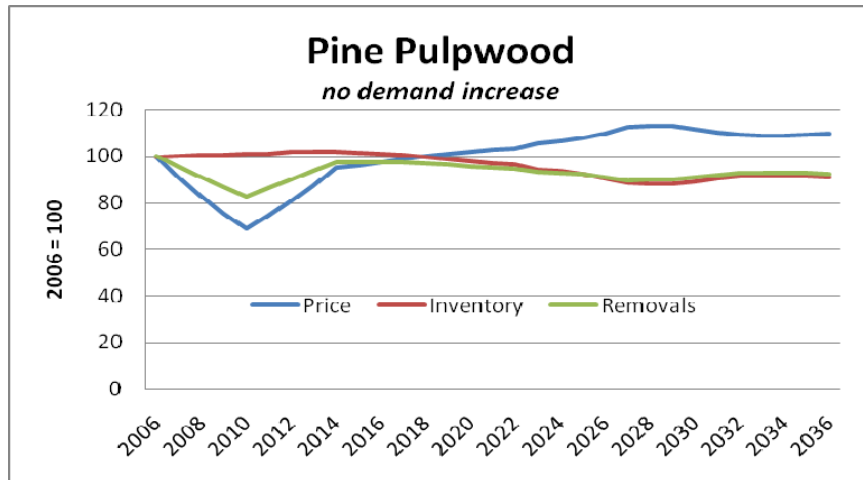


Figure 5. Pine Pulpwood trends for inventory, removals, and price assuming no demand increase due to bioenergy

The initial reductions in demand (harvest) and price are attributed to the ongoing recession. As the economy recovers removals increase and push inventory down creating upward price pressure on pine pulpwood from 2016 to the end of the simulation. Figure 9 depicts the trends for pine sawtimber. After the initial short-term shock associated with the current recession inventory and harvest are in balance providing no substantial pressure on sawtimber price in the no demand increase scenario.

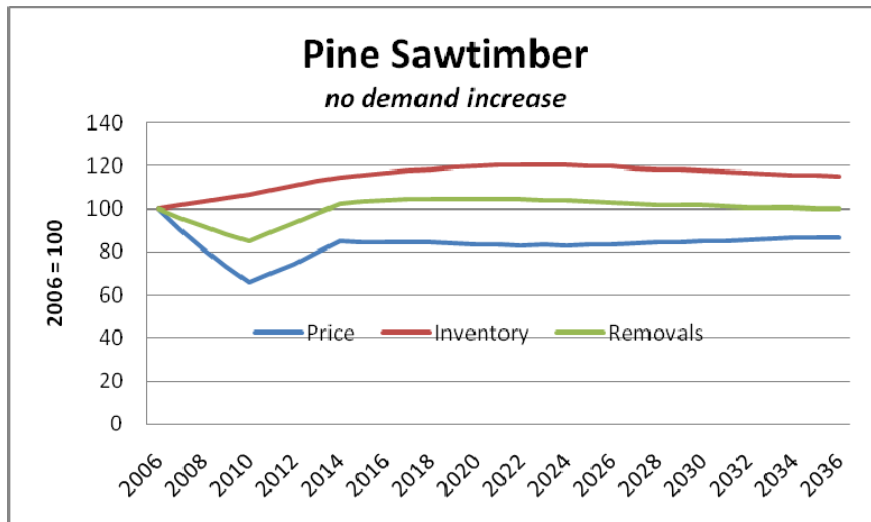


Figure 6. Pine Pulpwood trends for inventory, removals, and price assuming no demand increase due to emerging wood-to-energy markets

Figures 7 and 8 document the expected trends for pine pulpwood and pine sawtimber under the assumption of a 50% increase in demand associated with emerging wood-to energy markets. Part of this demand is satisfied through the harvest of logging residuals while some is produced by harvesting pine pulpwood. The initial decline associated with the recession pine pulpwood decline creating substantial upward pressure on pulpwood price. The resulting trend for sawtimber takes longer and is less pronounced over the simulation period.

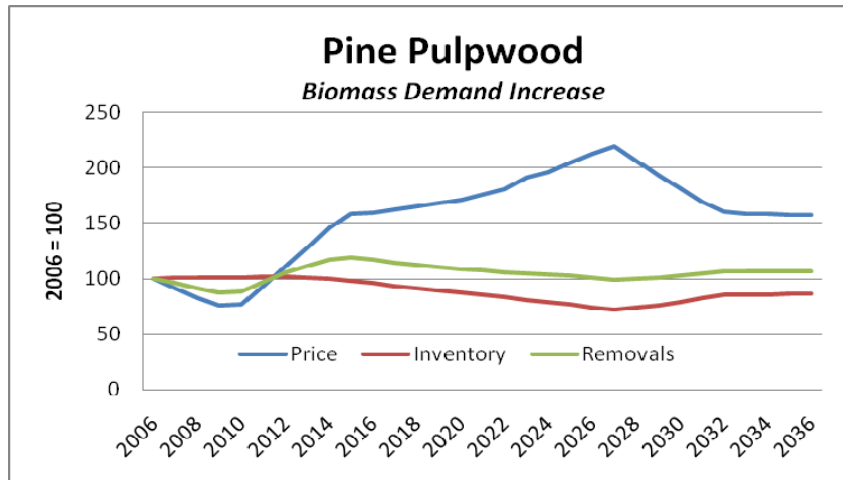


Figure 7. Pine Pulpwood trends for inventory, removals, and price assuming a 50% demand increase due to bioenergy

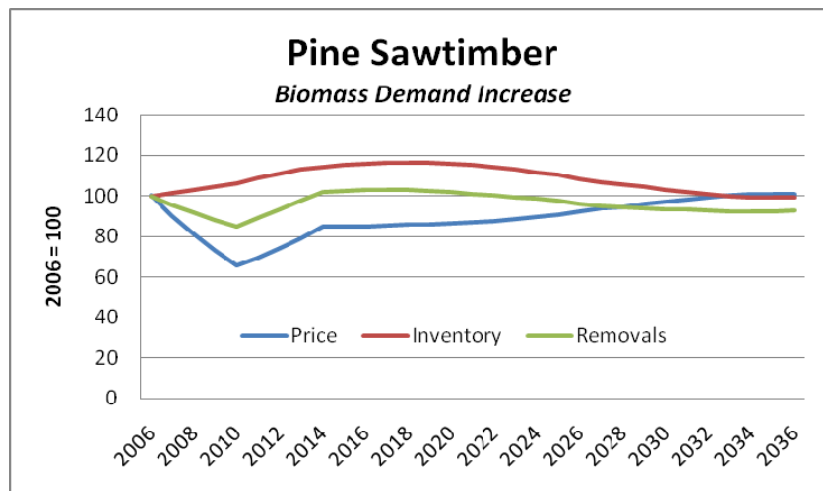


Figure 8. Pine sawtimber trends for inventory, removals, and price assuming a 50% demand increase due to bioenergy

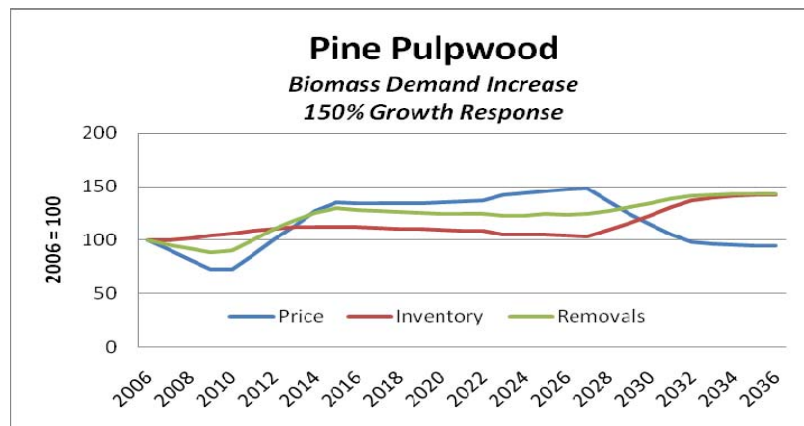


Figure 9. Pine pulpwood trends for inventory, removals, and price assuming a 50% demand increase due to bioenergy and a 150% growth increase on corporate timberland plantations and a 75% increase on NIPF plantations.

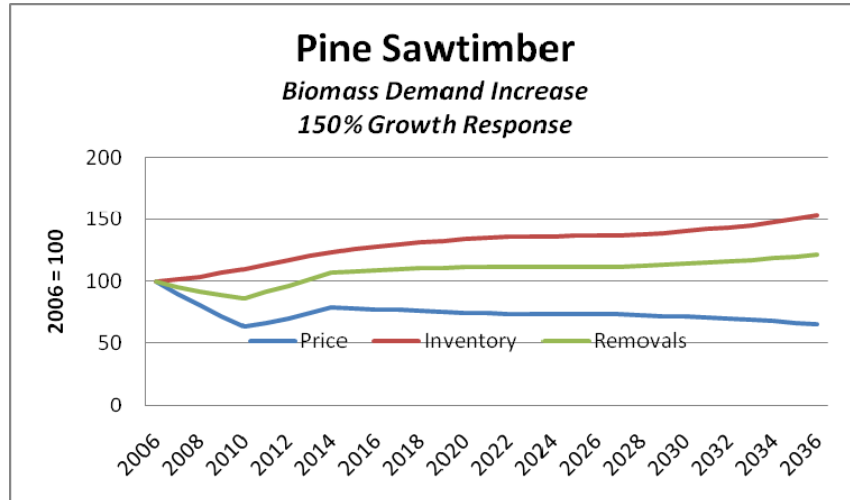


Figure 10. Pine sawtimber trends for inventory, removals, and price assuming a 50% demand increase due to bioenergy and a 150% growth increase on corporate timberland plantations and a 75% increase on NIPF plantations.

Our simulations document the inventory, harvest, and stumpage price trends for pine pulpwood and pine sawtimber assuming both increased demand and increased growth on private ownerships. As expected, the increased growth rates mitigated the substantially increasing prices for pine pulpwood during the simulation time horizon. This result documents the possibilities for reducing medium to long-term timber scarcity through the use of increased silviculture intensity. The growth rates implied in the analysis are still well below expected productivity levels discussed earlier that are associated with intensive forest management experiments. The sawtimber trends depict a market abundance of pine sawtimber throughout the simulation.

While these results are not particularly unexpected, many fail to recognize the extent to which landowner behavior, influenced by developing markets and increasing stumpage prices for pine pulpwood, can impact wood-to-energy opportunities. While this example is Southern based, similar results are expected in any region where there exists (1) opportunities to increase growth rates with more intensive forest management, (2) there is a significant private land component to the landscape, and (3) investment funds are available to pursue the more intensive forest management practices.

Conclusions and Policy Implications

In closing, there are a number of important findings of our research. They include:

- There exist substantial regional differences forest resources in the United States. Attributes such as species composition, stand type, ownership patterns, etc. are important trends to consider when assessing wood-to energy opportunities. These regional differences will impact how quickly and to what extent wood-to-energy markets develop across the United States. Clearly, the greatest opportunities for large healthy biomass markets exist in the South and Pacific Coast regions based on current and expected future raw materials supplies.
- Logging residuals will make up part of the raw material provided to wood-to-energy facilities. However, if pulpwood is included in the biomass definition then in many cases, at least initially, it will be less expensive and of higher quality to wood-to-energy facilities. Additionally, if pulpwood is not included in the definition then wood-to-energy opportunities will be hampered by a lack of supply in most regions of the United States.

- There exist substantial opportunities to increase forest productivity through intensive forest management – particularly in plantations in the Pacific Coast and Southern regions of the United States. However, a primary component of that strategy will be timber prices that induce private forest landowners to invest in tree growing technology.
- Landowner responses to developing markets play a primary role in meeting the future timber needs of a developing wood-to-energy sector. While supply may be inelastic in the short-run, it becomes less so in the medium and long-run. These landowner responses clearly increase supply and decrease raw materials costs in the long-run providing a secure and plentiful raw materials supply to the developing wood-to-energy sector.
- Emerging local bioenergy markets will focus initially on currently available raw materials in that locality. Hence, where wood is plentiful it will be recognized as an important element of the bioenergy answer – as long as it is not precluded by regulation.