Future Bioenergy Demand, Development Pressures, and Forest Area:

Case Studies in the Southeast US

Report to the National Wildlife Federation

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Highlights

This report summarizes a brief analysis of the question: *is it likely that higher pulpwood prices, driven by increased bioenergy demand, in the Southeast will affect the conversion of currently forested land to development?* To answer this, we adopted a Case study approach of two areas, the Raleigh-Durham-Chapel Hill metro area, and the Savannah area. We have used assumptions favorable to the argument that higher prices will cause existing forests to be retained.

Projections indicate that rising exports of fuel pellets could boost pulpwood stumpage prices by as much as 100% for a period of time, based on recent work by Abt, et al. (2014). Higher prices for pulpwood will raise revenues for landowners, most strongly those managing on short pulpwood rotations. But timber sale revenues are low compared to raw land prices for development, even with higher pulpwood prices. As an incentive for retaining forest, on land vulnerable to development, this would have little effect.

There are no publicly available price quotes for stumpage values of culls, branches, and topwood sometimes chipped as biomass fuel, but in local areas where such markets exist, we doubt they would change our results.

Lands shifts to suburban development based on demand for lots. Our estimates are that raw land for development can bring between $1,700/acre in the very cheapest situations, to $6,000 or more on average, and much more at favored locations.

For landowners considering only annual cash revenues, existing well-managed forests could potentially earn annual returns competitive with development in remote areas and on lands poorly suited to development. Capitalizing returns for well stocked and well managed forests yields a value of $2,500 per acre (at 4% interest). Landowners focused on asset values would not find forest uses competitive, except for situations that are remote or less suited to alternative uses.

Based on population density, half of the forest area in the Raleigh area is already at high risk of transition to development, and 10% in the Savannah area. In those transition areas, active management is likely to ebb away.

Considering the above, the burden of proof is on those advocating that higher pulpwood or biomass prices will retain existing forest. As yet, that burden has not been met.

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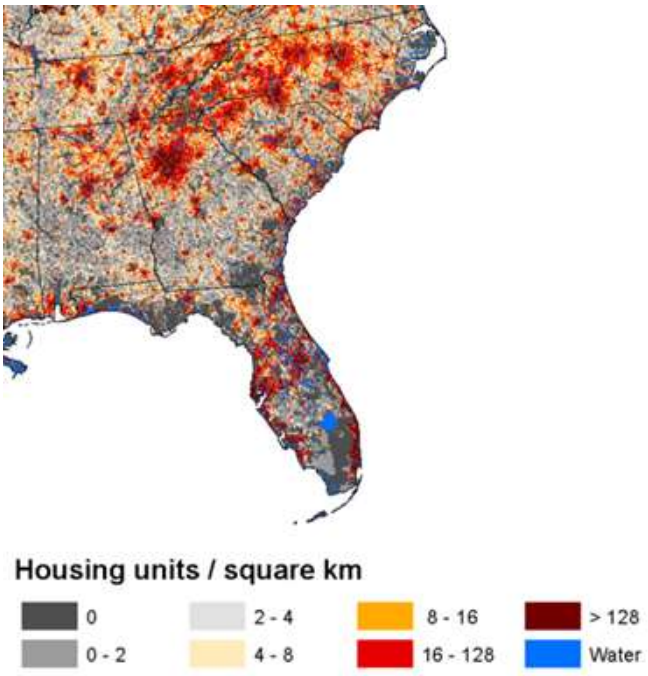
Introduction

This analysis was stimulated by rapid growth in exports of wood pellets, by expected growth in use of biomass for power generation, and turmoil in wood markets caused by shrinkage in pulping capacity.

Conversion of forests to urban uses has emerged as a major issue in the South. A US Forest Service "Big Four" issue is conversion of land away from forests. Rapid population growth, low-density spread of suburban boundaries, and the general dispersal of housing patterns across rural landscapes, have become major variables in understanding the future of southern forests. Future trends in development will shape not only the forests themselves but public access, wildlife populations, and many other forest and community values. Suburban influence can be measured in a number of ways. Housing density per unit area is one. In our three state study area, a map of 2010 housing unit density shows three strips of development: one along the coast, including well known resort destinations such as Beaufort, Myrtle Beach, and North Carolina's Outer Banks; a series of cities along the upper edge of the Coastal Plain (termed "flatwoods" in Georgia); and then a series of Piedmont cities still further inland. The concern for forest area, however, is not so much the increases in population and housing, but the wide spread of low density development (Hart's "Spersopolis") away from past suburban fringes.

Figure 1. Housing unit densities in the Southeast, 2010



http://silvis.forest.wisc.edu/maps/housing_main

As a recent report noted:

> "In the last decade or so, the US has been losing forest and open space at an estimated average rate of about four acres per minute. If trends in the US continue unabated, increases in urban development are expected to expand by 41% by 2060, with most of this development occurring at the expense of forests. Forests lost to development in the southeastern US alone, a region that has tremendous natural forest carbon sequestration capacity, are projected to be as much as 9.7 million acres by 2050—a land area about twice the size of New Jersey." (Zhao 2013)

In recent years, a series of pellet plants have been built or announced, mostly large scale plants for shipment of pellets to Europe. These are expected to consume enough wood fiber to affect the price of pulpwood (pellet plants buy wood that is essentially the same as pulpwood). Based on Abt, et al (2104), we will assume that these exports will double the price of pulpwood. Biomass use for power generation is also likely to increase. The argument has been heard that higher prices of pulpwood grade fiber would lead to less conversion of existing forests into suburban fringe land uses. How plausible is this argument?

Senior USDA officials suggest that this will be the case.

> *"Markets work. Increasing forest productivity and health makes them more valuable and less susceptible to conversion to other uses. Vibrant markets for wood materials raise the value of forest lands and encourage investment, regrowth and expansion."* (Robert Johansson, USDA Acting Chief Economist, on June 8, 2015, USDA Blog post)

> *"Part of what drives land use conversion is loss of private income from forest lands. The Forest Service is working to increase potential income for private landowners from a variety of sources. Our researchers are developing new ways of utilizing low-value wood, such as cross-laminated timber for construction and biomass for energy production."* (Tom Tidwell, Chief USFS)

On the other hand, people working in forestry in the region disagree:

Early in this study a consultant with real estate experience noted to us:

> *"Even more valuable saw products cannot slow development. It would have to push Bare Land Value of Soil Expectation Values above $5,000 per acre on the outer fringes, closer to urban areas would likely be $20,000 per acre or more to match the higher and better use of development or HBU. With water and sewer in some areas the land can be $30,000-$100,000 per acre. No way trees can ever produce the kind of income to match that. The more development in area the less attractive it is for harvesting as well as loggers do not want to work in high traffic areas due to slower production, more opportunity for accident, more opportunity for complaints from neighbors, etc."*

This report summarizes a brief inquiry into this question. For brevity, it places some of the analysis in attachments, and cites sources only for points noted in text; a list of supporting references used in the research is attached.

Study Question and Method

This research is an initial scan designed to shed light on the question:

Is it likely that higher woody biomass prices in the Southeast will affect the conversion of currently forested land to development?

Our approach followed several steps:

First, we selected two case study areas. These are the Raleigh Durham Chapel Hill, a projected high growth metro area; and Savannah, a coastal area expected to experience somewhat less rapid growth. The intent was to focus on two specific areas as examples of a range of development pressures.

Drilling down into two case study areas will yield insights even if it does yield a final answer to the question on a Southwide basis. Timber markets and prices vary significantly across the South, as do metro area economic conditions and prospects. Further, the prospects for farmland conversion vary a great deal. We conducted interviews for insight into property markets in these areas and to locate examples of prices paid for land in the suburban – forest transition. We reviewed previous literature studying these questions, and from them derived estimates of urban growth effects on forest area.

We make assumptions that are most favorable to the argument that higher biomass prices will lead to increased investment in pine planting, on a with-without basis.

Study Area

Savannah is the second largest port on the East Coast by cargo volume. Nearby is a large military installation, Fort Stewart. Savannah also sits in the middle of a prominent growth area for tourism and recreation, including active retirement development, spawned by the urge to own and live in coastal property. Despite these advantages, projected population growth is modest. Because this metro area straddles a state line, we have included nearby South Carolina, for a total of 9 counties (see lists in Attachment B). This area contains 2.2 million acres of forest land (not timberland). Savannah's population increased only 5% from 1990 to 2014. Between 2010 and 2040, the two-state metro area is expected to grow by 306,000, or 42%, according to projections by the USFS for the 2010 RPA analysis (averages of the 3 scenarios reported in Zarnoch, et al. 2010). Of this, a bit more than one third is projected to occur in the 7 noncore counties.

Raleigh-Durham-Chapel Hill (The Triangle) has been a standout growth region in recent decades. The Raleigh-Durham area alone grew 88% from 1990 to 2014. From 2010 to 2040, USFS projections expect the area to gain an additional 893,000 persons, or 47%. Of this increase, 260,000 is projected in the 9 noncore rural counties. Today, North Carolina is almost covered by counties in SMSA's or micropolitan areas. This 12-county study area contains 2.2 million acres of forest land.

It would be reasonable to suppose that for every additional person added to the population, one half acre of land in total will be converted to residential and commercial land uses. This is a conservative figure. If true, it implies that the Raleigh area could see 450,000 acres of rural land converted to development by 2040 compared to 2010; the 2-state Savannah metro could see 150,000 acres converted. Not all of this, of course, would be forest land.

Past Changes in Forest Area: A Complex Dynamic

North Carolina's Assessment report shows that from 2002 to 2007

> *"North Carolina's timberland increased by nearly 362 thousand acres. Additions to timberland from nonforestland were about 966 thousand acres while approximately 667 thousand acres of timberland were diverted to non-timberland uses. Urbanization and agriculture accounted for 92 percent of the diversions. Losses to urbanization were more than double the losses to agriculture."* (p. 31)

These comparisons show the complexity of land use changes – the net change emerges from large flows in both directions, showing how different forces are at work. This likely reflects very different patterns of change in different areas of the state.

Analysis by the Georgia Spatial Analysis Lab showed that from 1985 to 2008, 2.6 million acres were converted to urban land cover types. This was roughly .77 acres per additional inhabitant. The bulk of this cover change was in low intensity urban use (e.g., low density sprawl); not all was forest. Surprisingly, this large change in land use caused only a small loss in forest area, according to this dataset.

In both states, the years measured include a major land boom. Clearly during those periods land was moving in both directions, both into and out of forest cover, responding to different forces in different areas. Clearly, analysis of forces affecting forest area must be both local in nature and multivariate in nature as well.

Property Markets and Land Values

Trends in Prices

During the boom years, Savannah showed a more prominent upcycle in real estate prices, likely related to the Atlanta boom, than did the Durham/Chapel Hill area (Fig. 2). To the peaks,

real estate prices had risen roughly fourfold in Savannah and threefold in Durham since the early 1980's. It is likely that the development pressure in Savannah area is underestimated by population data as these cover only year-round residents and not seasonal or weekend populations. For both farm real estate in total and for pasture, the 2000's property boom showed a clear statewide influence in Georgia. In NC and SC the effect of the boom, though, was barely visible (Fig. 3). Except for South Carolina, pasture prices exceeded the average for farm real estate per acre. These levels suggest the pressures for converting forest to agricultural uses.

Figure 2

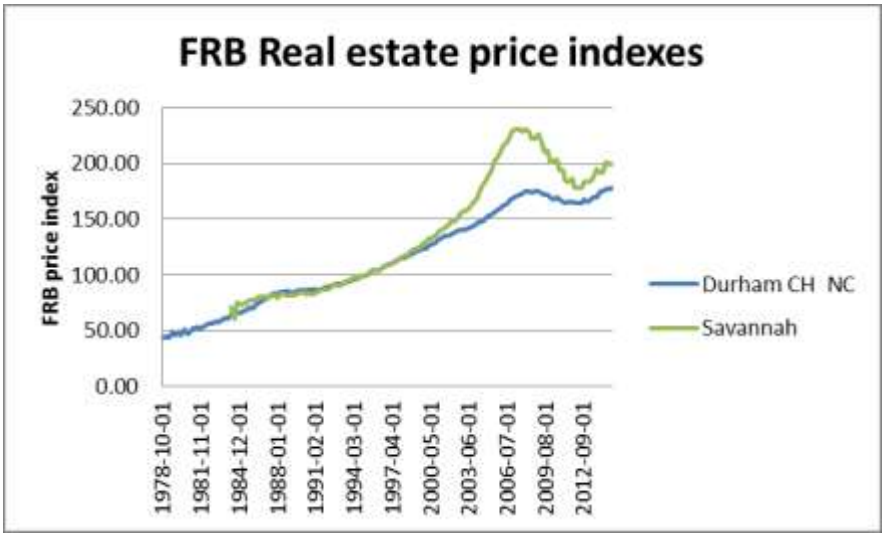
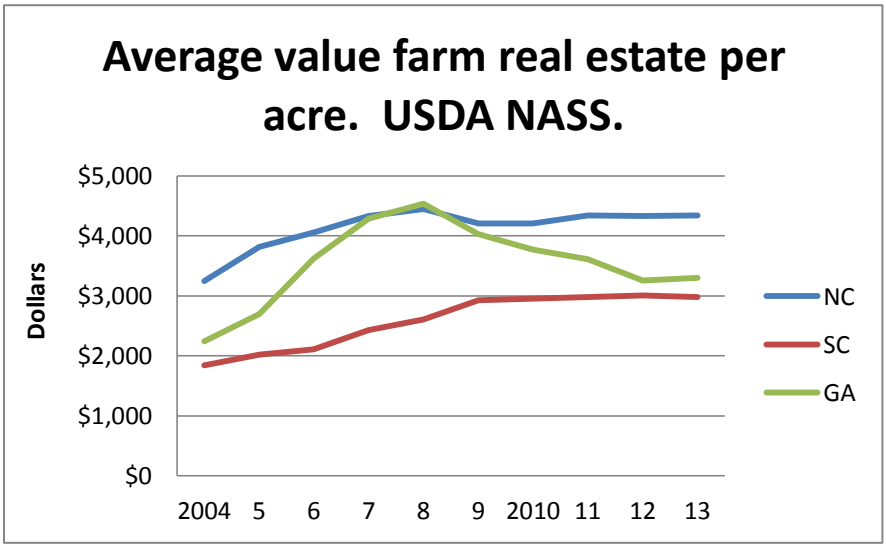


Figure 3



Raw Land Values for Development

We have only anecdotes on raw land prices in the suburban fringe, so we will work with some general rules for the industry. The Lincoln Institute for Land Policy issues a quarterly estimate of finished lot prices, available by state. Details on this data and our estimates are in Attachment A. We estimate raw land at 3% of house value, and then adjust the county land prices to the same relationship to their respective state averages as applies for home prices (Table 1). This yields estimated raw land costs of just under $2,000 for the lowest cost counties in the Carolinas, and just above $3,000 for Georgia[1]. Actual prices for land sold for development in most areas would probably lie in the range between the low and high estimates, depending on size, location, soils, and amenities. While detailed work in local property records, supplemented by interviewing would be required to obtain solid numbers, we believe these estimates suffice for an exploratory effort.

Table 1.

Table	Estimated House Prices and Raw Land prices			
	Averages 2012 to present			
	State Averages			
	Total	Finished Lot	Raw land at 3% of house	Raw Land at Lowest County*
NC	$231,298	$60,334	$6,939	$1,804
SC	$221,265	$52,837	$6,638	$1,726
GA	$187,606	-$36,294	$5,628	$3,377
	*Sampson at 28% of state average			
	Hampton at 26%			
	Long at 60%			

One may object that during land booms, developers and their lenders are overoptimistic, so that this procedure underestimates raw land prices. Also, the 3% rule was being advocated during the "hangover" period, when a demoralized real estate industry was still absorbing bankruptcies of developers, aggressive property speculators, and lenders. It may also be noted that these prices refer to existing houses and lots and not to new homes, which likely biases the results downward. These points are surely correct. A reasonable price range to consider as a sales price for rural land ripe for development would probably be no less than these estimated raw land values

[1] These values are below what USDA estimates show for prices for pasture land, which in many areas would be desirable for development.

and no more than pasture prices. In this analysis, we believe that our results yield low raw land values, which fits the approach being taken here.

Retaining Forests as Forests

As noted above, the net changes in forest area result from shifts into and out of forest uses. We have only aggregate data on these shifts at state level, which obscure regional differences and do not measure condition of the forest lands that are leaving forest uses. In North Carolina, from 2002-2007, twice as much forest went to development as to agriculture. How might higher pulpwood prices influence retaining land in forest? This can be examined from the perspective of annual incomes and then also of asset values.

Annual Income Perspective

Surveys indicate that many rural forest owners do not own woodlands primarily as a source of income. For this reason it is hard to model how such owners might respond to changes in either crop prices or timber prices. In the case of a well-stocked forest, whether planted or natural, the annual income possibilities can be as high as $100/acre[2], so that retaining forest would be financially interesting. The question is, how much difference would pulpwood prices make?

Better pulpwood prices would improve the economics of thinnings, improvement cuts, or other measures need to improve sawtimber growth. To understand this fully would require intensive research and modeling[3]. Stronger volume markets and higher pulpwood prices would induce more of these intermediate treatments, with current financial benefits as well as improved future stand productivity. How much doubled pulpwood prices would affect landowner incomes is difficult to measure. Clearly, operating in well-stocked and managed stands will generate pulpwood as a normal product. In improvement cuts or thinnings, material of pulp size or grade will be prominent, in final harvests in mature stands, much less so. So, we can conclude that, for landowners focusing on annual incomes, higher prices would likely improve the odds of owners retaining forest, in cases where the lands are already at a high level of management and generating cash flow. What we don't know is how much of the land in the expanding suburban fringe is managed at a level that could yield such high incomes. It may not be large.

We have reviewed several examples of timber sales in the study areas. If at all typical, they suggest that sale revenues on many properties, when offered for final harvests, can be as high as $1,000 to $1,200 per acre. Surely the best individual acres could be much higher, but the typical property does not consist entirely of mature stands of prime timber. These examples suggest that the impact of doubling pulpwood prices could increase timber sale revenues by 5 to 20%. Converting this to a realistic present value is uncertain, as some properties do not have operable

[2] Handley and Dickinson, 2013, give examples supporting this estimate. It would apply only to well-stocked and well managed land.

[3] A detailed analysis by McIntyre of a forest property in Georgia illustrates the complexities nicely.

timber volume at present, or are too small to support a commercial operation. Others are affected by riparian buffers or other restraints. All the same, even if a harvest is practical at the present moment, unless the forest is well stocked with highly valuable timber, an immediate harvest is likely to yield less than a sale to a developer.

In areas near biomass-fired generating plants or cogeneration facilities, topwood, branches and even foliage can be chipped, blown into trailers, and sold. How might improved markets for logging residues affect landowner returns? We have not found any publicly available price quotations for logging residues on a stumpage basis. Estimating recoverable volumes on a local basis is fraught with many uncertainties. In some areas, in place values may be zero or negative[4]. Where markets permit, the removal and sale of as much as 20-40 tons per acre of such material would be possible. At prices of $2 per ton, this could add up to $80 per acre to harvest revenues. Overall, however, the revenue impact would be modest compared to the solid wood products being sold. Such revenues would only be available when stands are clearcut.

We can compare the annual income for forest management with what could be realized if the land were sold and the proceeds invested in a safe security. At present, 5 year CD's are yielding in the 2.5% range; 30-year Treasuries yield 3%. In the future, interest yields could be higher, but so would inflation. The risks in a CD or Treasury bond are arguably less than those of holding land in forests, as most owners would view the matter. At a minimum, the financial instruments are far more liquid than forest property. Results (Table 2) show that annual income returns to these financial investments would far exceed those available for even well managed forests, in any area with state average land prices. The lowest price counties, returns could be competitive.

Table 2.

Table	Interest Yield if Sold, With Proceeds Invested In:			
	State Average		Lowest County	
	30 Yr T-Bond	5 Year CD	30 Yr T-Bond	5 Year CD
NC	$208	$173	$54	$45
SC	$199	$166	$52	$43
GA	$169	$141	$101	$84
Rates	3.00%	2.50%	3.00%	2.50%

[4] Where being prepared for planting, cutover areas may be "biomassed" to clear the land for efficient planting. This may be done at a net cost.

Many families have a strong attachment to the land and want it to remain in rural uses. Yet, such owners pass from the scene and their heirs or subsequent owners have multiple motives for being concerned about asset values as well as annual incomes.

Asset Value Perspective

A managed forest yielding a $100/a/yr net income could be valued at no more than $2,500.00, even at a low discount rate of 4%. To earn such an income, the forest must maintain growing stock that would likely average $1,000 to $2,000 per acre. When comparing to recent prices for development, these estimates suggest that forest management for land in the high price counties but could compete in lower cost counties in North and South Carolina (Table 3).

Table 3. Comparisons of Managed Forest Value and Competing Uses

State	Well Managed Forest at 4%	Est. Development Value (low county)	Est. Development Value(high county)
North Carolina	2,500	1,804	6,939
South Carolina	2,500	1,726	6,638
Georgia	2,500	3,377	5,628

Another indication of timberland asset values is supplied by timberlands that are being acquired by investment groups for prices in the range of $1,800 to $2,200 per acre. These prices are considered optimistic by some observers and doubtless include some level of revenue from sales of high value parcels. They are not typical of regional forests, however, because they are large in scale, typically well stocked with managed pine, and may be owned by tax exempt entities such as pension funds.

Amenity motives are often ignored in analyzing these problems. For example, new owners at the suburban fringe are often interested in having horses, for them converting woods to pasture might be natural regardless of financial considerations. Another amenity use, generally highly compatible with forest management, is properties acquired for hunting. While large areas are already under lease for hunting, there are groups who wish to own parcels for this purpose. They need not be large.

How Much of This Land is at High Risk of Development?

Comparing land values for farming and development with returns to forest management is useful. But this tells us little about the likelihood of conversion to development. Without development pressure, land use will remain unchanged. Previous literature offers some guidance in assessing the likelihood of land conversion (Wear and Newman 2004; Wear, et al. 1999).

While this work refers to somewhat different areas and to a past time period, it offers a framework for thinking about our questions. What do the relationships uncovered in those studies suggest?

An important correlate of conversion risk is population density, which is naturally related to land values. In their Georgia study, the odds of conversion rose with population per square mile. They describe a "transition zone" as 200-350 persons per square mile (psm). They suggest that above 400 psm, long term timber production is unlikely. We have applied these estimates to county data on commercial forest land (Sonia Oswalt, FIA- Knoxville, pers. comm.), and Census 2010 population densities from American Fact Finder.

In the South Carolina portion of the study area, Beaufort County accounts for only about 10% of the total forest – all of it in the "transition zone" (Attachment B). Similarly, Chatham County, GA (Savannah) is as densely populated as many of the more urbanized counties around Raleigh. In the adjacent Georgia counties, none are in the transition zone for population density. The urban influences of the core counties in this area fall off rapidly with distance. For the Savannah area as a whole fully 1.2 million acres of forest is below 50 psm -- well below the transition zone. But in this coastal area, demand for seasonal property is not measured by resident population. So, development pressure is probably underestimated by relying on resident population.

In the Raleigh metro area, the core counties are in the zones where Wear and Newman would judge forest management to be unlikely. In total, half of the forest area in the region is in the transition zone. The lowest in population density is Sampson, an important agricultural county. Significant forest expansion would be most likely in the 5 counties with the lowest population density. This would be 1.1 million acres, half of the forest area in the study counties.

In the extensive literature on farmland conversion, experts emphasize concepts like "shadow conversion" or "the impermanence syndrome." These reflect the fact that as the suburban fringe expands outward, owners of the land remaining in farming begin to minimize investments in anticipation of being able to sell all or a portion of the land. It is often said that the area affected by this syndrome is a multiple of the area that actually sprouts houses. In our interviewing, we have been told that this phenomenon also applies to forest management. This is fully understandable when looking at the immense wealth bestowed upon rural landowners in past decades by low density development. Interviewees note that the exceptions to this are properties under the use value tax provisions of the respective states.

Conclusions

Several conclusions emerge from this brief review:

First, these estimates of the prices being paid for land by developers show that forest management can compete with development only for lands in remote areas and that are unsuited

for development. This argument is based on assumptions that most observers would find highly favorable to the case for forest management being able to retain land in the face of development pressure. Utilizing logging residues and cull wood for biomass chips can boost revenue from a timber sale, where a strong biomass market already exists. But it could not bring forest land values to levels that could compete with development.

Second, based on previous research, which estimates the risk of conversion of land to development, we estimate that at least half of the forest land in the Raleigh area, and at least 10% of the land in the Savannah region, is already in "transition" situations where conversion risk is high. In the Raleigh area, 12% of the remaining forest is in counties where population densities make future forest management unlikely.

On a local level, conversion of land is driven by demand for lots. What forest owners think their land is worth for growing trees has no effect on demand. If another 200,000+ houses are to be built in the Raleigh-Durham-Chapel Hill metro in the coming 20 years, that volume of demand will determine how much land is actually developed and removed from rural uses. Higher prices for low value wood products will not change this.

Markets do not care if forests persist. Individual land buyers, speculators, or homeowners don't care either. Many families in the region have strong feelings for the land, but the odds that those feelings will survive into the next generation are uncertain. In the end, the only way to retain land in forest in the face of development pressure is to find practical ways to do these things:

- See to it that development becomes much more much more efficient in how it uses land.
- Apply conservation easements much more widely.
- Increase participation in use value taxation programs.
- Better yet, do all of these at once.

Based on our analysis for these case study areas, we would argue:

To suppose that expanded biomass use and pellet exports, by doubling prices for low grade wood (in a with-without sense), will retain existing forest in the face of suburban and exurban land use pressures is not supported by the data or by practical experience.

The burden of proof lies on those advocating this line of argument, and it has not yet been met.

References for SE Biomass Study

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. Asheville, NC: US Forest Service, Southern Research Station, Gen. Tech. Rept. SRS-202. 33 pp.

Alig, R., S. Stewart, D. Wear, S. Stein, and D. Nowak. 2010. Conversions of forest land: trends, determinants, projections, and policy considerations. In: Pye, J., H. M. Rauscher, Y. Sands, D. C. Lee, J. S. Beatty, tech. eds. Advances in Threat Assessment and Their Application to Forest and Rangeland Management. Portland, OR: US Forest Service, Pacific Northwest and Southern Research Stations, Gen. Tech. Rep. PNW-GTR-802. pp. 1-26.

Baker, J. B. M. D. Cain, J. M. Guldin, P. A. Murphy, and M. G. Shelton. 1996. Uneven-aged silviculture for the loblolly and shortleaf pine forest cover types. US Forest Service, Gen. Tech. Rep. GTR-SO-118. 65 pp.

Burton, J. D. 1980. Growth and yield in managed natural stands of loblolly and shortleaf pine in the west Gulf coastal plain. US Forest Service, Res. Pap SO-159. 23 p.

Cain, M. D., and M. G. Shelton. 2001. Natural loblolly and shortleaf pine productivity through 53 years of management under four reproduction cutting methods. *Southern Journal of Applied Forestry,* 25(1):7-16.

Chang, S. J. 1990. An economic comparison of even-aged and uneven-aged management of southern pine in the mid-south. Presented at SoFEW 1990 spring workshop, Monroe LA.

Coulston, J. W., G. A. Reams, D. N.Wear, and C. K. Brewer. 2013. An analysis of forest land use, forest land cover and change at policy-relevant scales. *Forestry*, 87:267-276.

Davis, M. A., and M. G. Palumbo. 2007. The price of residential land in large US cities. *Journal of Urban Economics*, 63(1):352-384. Data located at Land and Property Values in the US, Lincoln Institute of Land Policy. www.lincolninst.edu/subcenters/land-values/metro-area-land-prices.asp (accessed 06/24/15).

Dixon, W. S. 2010. Sampson County working lands protection plan. North Carolina Cooperative Extension, Sampson County Center. 63 pp.

Field, D. B., and L. C. Irland. 1980. Impacts of suburbanization on timber growing: A case study of the State of Connecticut. *Connecticut Woodlands*, Summer:16-24 and Fall:21.

Georgia land cover database: http://narsal.uga.edu/glut/data-stats/georgia-landcover-trends.

Handley, D. M. and J. C. Dickinson. 2013. A better way – uneven aged management of southern pine. In: Guldin, J. M., ed. Proceedings of the 15th Biennial Southern Silvicultural Research Conference. Asheville, NC: US Forest Service, Southern Research Station, Gen. Tech. Rep. SRS-GTR-175. pp. 39-43.

Hardie, I., P. Parks, P. Gottlieb, and D. Wear. 2000. Responsiveness of rural and urban land uses to land rent determinants in the U.S. South. *Land Economics*, 76(4):659-673.

Hart, J. F. 1991. The land that feeds us. New York: W. W. Norton and Company. 398 pp.

Irland Group, 1988. Maine's land boom: Land use trends, causes, concerns, and policy trends. Unpub. report to Commission on Maine's Future. Nov 9, 1988. 54 pp.

Irland, L. C. 1996. Land, timber and recreation in Maine's Northwoods. Orono: Univ. of Maine Agr. Exp. Sta. Misc. Publ. 730. 81 pp. http://digitalcommons.library.umaine.edu/cgi/viewcontent.cgi?article=1035&context=aes_miscpubs (accessed 06/24/15).

Irland Group. 1990. Case studies in land use change: Overview of the Northern forest lands. In: Harper, S. C., L. L. Falk, and E. W. Rankin. The Northern Forest Lands Study of New England and New York. Appendix D, pages 104-115. http://babel.hathitrust.org/cgi/pt?id=umn.31951002977815k;view=1up;seq=6 (accessed 06/24/15).

Irland Group with Seneca Economics and Main Street Economics. 2004. Forest production, industry and retention assessment. Final report to Maryland Agro-Ecology Center, Wye, Maryland. MCAE Pub. 2004-1.

Lang, A. 2014. How wood demand from bioenergy affects forecasted pulpwood prices in the South. www.forisk.com/blog/2014/10/20/wood-demand-bioenergy-affects-forecasted-pulpwood-prices-south/ (accessed 06/24/15). Also in *Forestry Source*, July 2015.

Lubowski, R. N., A. J. Plantinga, and R.N. Stavins. 2008. What drives land-use changes in the United States? A national analysis of landowner decisions. *Land Economics*, 84(4):529-550.

Martinuzzi, S., J. C. Withey, A. M. Pidgeon, A. J. Plantinga, A. J. McKerrow, S. G. Williams, D. P. Helmers, and V. C. Radeloff. 2015. Future land-use scenarios and the loss of wildlife habitats in the southeastern United States. *Ecological Applications*, 25:160–171.

McIntyre, R. K., S. B. Jack, B. B. McCall, and R. J. Mitchell. 2010. Financial feasibility of selection-based multiple value management on private lands in the South. *Journal of Forestry*, July/Aug. 2010:230:236.

Murray, B. C., R. C. Abt, D. N. Wear, P. J. Parks, and I. W. Hardie. 2001. Land allocation in the southeastern US in response to climate change impacts on forestry and agriculture. *World Resource Review*, 13(2).

Nagubadi, R. V., and D. Zhang. 2005. Determinants of timberland use by ownership and forest type in Alabama and Georgia. *Journal of Agricultural and Applied Economics*, 37(1):173-186.

North Carolina Forest Service. 2010. North Carolina forest assessment, (ch. 2 Conserving Working Forest). North Carolina Division of Forestry.

North Carolina Forestry Association. 2014. New approaches to conserving working lands in North Carolina. www.ncadfp.org/documents/WorkingLandsConservationNCFADiscussionPaper.pdf (accessed 06/24/15).

Radeloff, V. C., E. Nelson, A. J. Plantinga, D. J. Lewis, D. Helmers, J. J. Lawler, J. C. Withey, F. Beaudry, S. Martinuzzi, V. Butsic, E. Lonsdorf, D. White, and S. Polasky. 2012. Economic-based projections of future land use under alternative economic policy scenarios in the conterminous *US Ecological Applications*, 22(3):1036-49.

Schulte, B. J., and J. Buorngiorno. 1998. Effects of uneven-aged silviculture on the stand structure, species composition, and economic returns of loblolly pine stands. *Forest Ecology and Management*, 111(1998):83-101.

Shinn, Jr., C., 2014. Paying too much for the land. http://www.builderpartnerships.com/Default/ViewResource/1237 (accessed 07/11/15).

Sohl, T., and K. Sayler. 2008. Using the FORE-SCE model to project land-cover change in the southeastern United States. Ecological Modelling, 219:49-65. http://digitalcommons.unl.edu/usgsstaffpub/572 (accessed 06/24/15).

Wear, D. 2011. County level projections of land uses under three future scenarios. Asheville, NC: US Forest Service, Southern Research Station, GTR-SRS-141.

Wear, D. N., and D. H. Newman. 2004. The speculative shadow over timberland values in the US South. *Journal of Forestry*, 102(8):25-31.

Wear, D. N. and J. G. Greis (eds.) 2002. Southern forest resource assessment. Asheville, NC: US Forest Service, Southern Research Station, Gen. Tech. Rep. SRS-53. 635 p.

Wear, D. N., and J. G. Greis. 2012. The southern forest futures project: Summary report. Asheville, NC: US Forest Service, Southern Research Station, Gen. Tech. Rep. SRS-168. 54 pp.

Wear, D. N., and J. G. Greis. 2013. The southern forest futures project: Technical report. Asheville, NC: US Forest Service, Southern Research Station, Gen. Tech. Rep. SRS- 178. 542 pp.

Wear, D. N.; R. Liu, J. M. Foreman, and R. M. Sheffield. 1999. The effects of population growth on timber management and inventories in Virginia. *Forest Ecology and Management*, 118:107-115.

Zarnoch, S. J., H. K. Cordell, C. J. Betz, and L. Langner. 2010. Projecting county level populations under three scenarios. Asheville, NC: US Forest Service, Southern Research Station, Gen. Tech. Rep. SRS- 128. 8 pp. with spreadsheet supplement.

Zhao, S. 2013. Land use and carbon dynamics in the Southeastern United States from 1992 to 2050. *Environmental Research Letters*. US Geological Survey.

Attachments

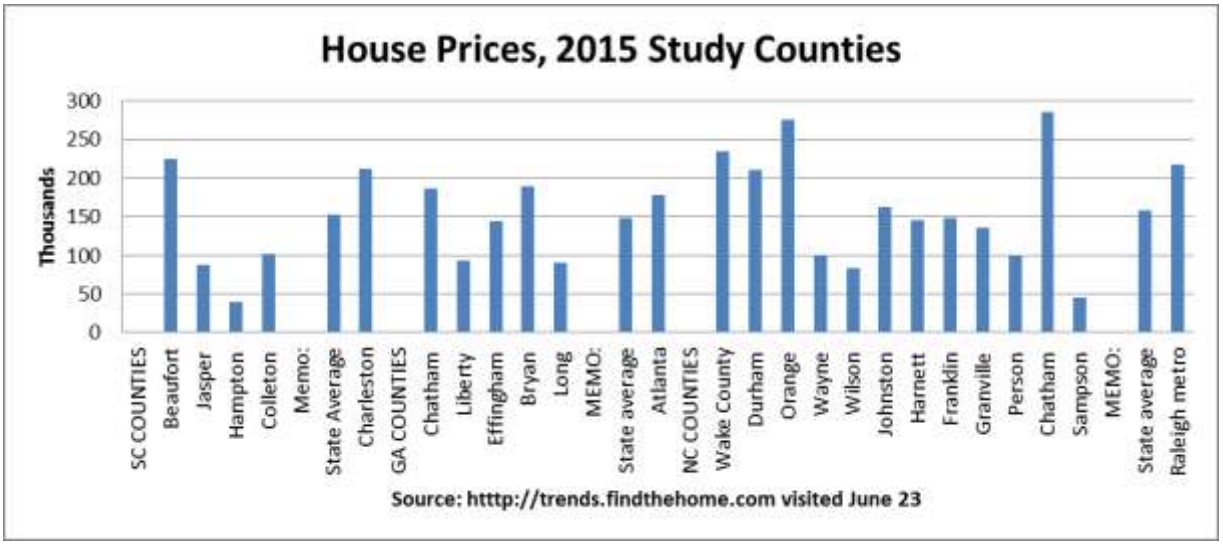
Attachment A. Backing into Raw Land Values for Development

A great deal of the effect of speculation on property prices comes back to raw land prices as developers scramble to find room for new homes. When the booms recede, land prices can plummet; the downswings are moderated by the fact that much land is taken over by lenders and withheld from the market. These estimates of finished lot costs do not directly measure raw land, as they include all costs and profits associated with bring raw land to buildable condition.

Figure A-1.

Principal concerns with this dataset are two: first, the size and location of the lots involved are not known, and they reflect a mix of sizes and levels of amenity. Further, they are state averages, blending the most rural, low income counties with the most sought after large-lot subdivisions in prestige neighborhoods. To develop a more realistic estimate of land values for rural areas, we take two steps. First, we obtained data on house prices in the study counties (Fig 6). Second, literature guiding developers on profitable land acquisition decisions recommends that developers pay no more than 3% of completed house prices for raw land. Our two-step adjustment process is shown in Table 2. Here, we show the state average house prices, and the 3% that would be paid for raw land under this rule.

Figure A-2


House Prices, 2015 Study Counties
Thousands
300
250
200
150
100
50
0
SC COUNTIES
Beaufort
Jasper
Hampton
Colleton
Memo:
State Average
Charleston
GA COUNTIES
Chatham
Liberty
Effingham
Bryan
Long
MEMO:
State average
Atlanta
NC COUNTIES
Wake County
Durham
Orange
Wayne
Wilson
Johnston
Harnett
Franklin
Granville
Person
Chatham
Sampson
MEMO:
State average
Raleigh metro
Source: htttp://trends.findthehome.com visited June 23

Attachment B. Areas at Risk of Development Measured by Population Densities

Savannah Metro Area

GEORGIA COUNTIES	PSM	Forest Area	County Rank by PSM	Percent	Odds of Forestry
Chatham	621.7	91,806	13	9%	unlikely
Liberty	129.5	232,439	45	91%	below transition
Effingham	109.4	235,777	50		
Bryan	69.3	199,046	75		
Long	36.1	229,995	118	23%	below 50 psm
TOTAL FOREST		**989,063**			

SOUTH CAROLINA COUNTIES	Pop. Density	2014 Forest	Rank by PSM	Percent	Zone
Beaufort	281.5	124,681	7	10%	transition
Jasper	37.8	311,384	40		
Hampton	37.7	253,781	41	90%	potential
Colleton	36.8	505,649	42		
TOTAL FOREST		**1,195,495**			

Total metro area: potential for continued forestry roughly 2 million acres below 200 psm.

Raleigh Durham Chapel Hill Metro Area

NORTH CAROLINA COUNTIES

	PSM 2010	Forest	Rank by PSM	Percent	Risk Zone
Wake County	1,078.8	157,276	2		
Durham	935.7	95,315	4	12%	Unlikely
Orange	336.2	136,229	13		
Wayne	221.7	165,319	23		
Wilson	220.6	84,742	24	38%	Transition
Johnston	213.4	230,491	25		
Harnett	192.7	208,674	27		
Franklin	123.3	197,641	46	50%	Potential
Granville	112.7	218,881	51		
Person	100.6	133,775	56		
Chatham	93.1	266,915	58		
Sampson	67.1	269,626	72		
REGION		**2,164,884**			

Attachment C. Statewide Counties and Forest Land by Population Density Class

Statewide Count of Counties by Population Density Class count of counties is from Col. B

	<20	20 to 50	50 to 100	100-200	200-400	400+	1000 + *
NC	2	14	28	30	17	9	3
SC	0	12	14	9	9	2	0
GA	11	56	37	24	11	20	5

* incl. in 400+

Source: US Census, American Fact Finder

Cumulative Forest Area SUM forest area is from Col. C

	<20	20 to 50 psm	50 to 100	100-200	200-400	400+	1000 + *
NC 2014	392,906	2,734,691	5,985,824	5,918,848	2,667,627	1,114,534	3
SC 2014	0	3,281,351	4,145,188	2,687,616	2,323,359	536,628	0
GA 2013	2,391,564	10,480,505	5,663,684	3,232,188	1,467,723	1,509,072	298,954

* incl. in 400+

Cumulative Forest Area PERCENT forest area is from Col. C

	<20	20 to 50 psm	50 to 100	100-200	200-400	400+	1000 + *
NC 2014	2%	15%	32%	31%	14%	6%	0%
SC 2014	0%	25%	32%	21%	18%	4%	0%
GA 2013	10%	42%	23%	13%	6%	6%	1%

* incl. in 400+

Source: Calc from Sonia Oswalt, pers comm June 2015.
In smaller counties, sampling errors can exceed 20%.

Attachment D. Observations on Previous Literature

We have looked in the literature for empirical studies that would allow us to make more quantitative and better-substantiated estimates. Considerable research has addressed the relationships between economic forces, population change, agricultural conditions, and climate change on forest area in the South (see reference list). A great deal has been learned about general relationships. In the era of "Big Data," however, much of the research on rural-suburban land use transitions employs huge datasets on national and regional variables. But it incorporates little if any direct interviewing and contact with market participants to understand the "soft" side of the trends being studied.

Land use change on the suburban fringe is intensely active during periodic "land booms" when population growth is rapid, financing is easy, and banks and developers are optimistic, if not absolutely delusional. Especially on the fringe, considerable subdividing occurs that leaves areas of raw land in limbo between rural and suburban uses. Orphaned, partially built out subdivisions may persist for years, as newer ones sprout up farther out. Modeling these cyclical changes in activity is very difficult; but assuming them away lends an air of unreality to projections.

Over decades, significant change occurs in the structure of property markets. For example, local land use regulations have changed, often causing more land consumption per additional unit than before. In some areas, large, well-financed regional operations are surviving in the development field, doing bigger projects. The implications for land use change remain unclear. Finally construction of Interstate highways, beltways and extensions prompt one-shot episodes of local sprawl. But what is clear is that econometric relationships established in the past, using data from pre-2005-06 boom conditions, may not be applicable to the future.

Surveys of forest owners make clear that ownership motivations and goals are complex, and can change over time. Land rents calculated from price and cost data make eminent sense for annual agricultural crops; such rents doubtless affect land use at the forest-pasture-cropland margins. But imputed rents for land in forest use become so abstract and full of assumptions that assuming that they affect owner decisions is tenuous at best. Looking at charts of the variations in stumpage prices in short periods of time, who can say how landowners, only occasionally in the market, form price expectations? Further, savvy landowners will see that the European pellet market is policy-driven. It could also be subject to competition from other entrants. Experienced owners have seen this before, when a boom in exports of hardwood chips to Japan peaked and then entirely fizzled out.

A complication in applying simple financial calculations on a per acre basis to a regional analysis is that the typical woodland property of any size contains many different forest conditions, with a wide range of values. Also some developers wish to buy one or a few lots, and others seek to obtain an entire property of 50 or 100 acres. Analyses of individual stylized acres cannot admit this complexity.

Attachment E. Complications and Disappointments

We are told that use value tax programs motivate owners to sustain active forestry in areas of urban transition. We were unable to locate accessible data on participation by counties to assess the influence of this factor. A careful review of this point for a larger sample of metros would be most informative.

Data on house prices can be found abundantly on a number of Web sources. MLS services are widely on the Web, for individual lots and homes. But such sources do not report raw land tracts that are being offered and are potentially interesting to developers. A good deal of slogging through the Web can turn up examples, but there is no way to ascertain their representativeness. We suspect that in the state tax agencies there may be databases of land transactions in these size classes that are used to develop the state assessed valuations. Time did not permit pursuing these.

We were not able to assemble current information on area of tree planting in these states. This has been a chronic problem for various sorts of forestry data. We need to know if current data suggest a rebound in activity from recent depressed levels or not.

It seemed to us initially that a likely location for investment in new plantations would be pastures that are not needed. But it an accurate database on pasture land by county does not exist (V. Dale, pers. comm.). Further, the rental and pricing data on pasture land is confusing and suggests that either: a) owners are applying extremely low cap rates to pasture transactions, or b) pasture prices statewide are dominated by potential home lot prices and not by their productivity for agriculture.

The Southern Research Station FIA information on land use change is exceptional in depicting a matrix of changes into and out of major land cover categories. Under the AFIS system, however, monitoring land use change for short periods of time is difficult. Nonetheless, it would be of interest to carefully review this information and discuss underlying trends with informed local observers.

Our analysis of counties for land use transitions relies on resident population densities. For areas with a high level of seasonal and recreational property, seasonal populations need to be considered. Further analysis based on housing densities in addition to population densities would likely improve our understanding of land use transitions. It could be that our analysis underestimates the forest area in the transition category.

Finally, there appears to be no standardized, county level database identifying “marginal farmland”. Existing research, based on aggregate modeling, suggests that 6 million acres of forest would be retained by higher bioenergy wood prices. Much of this is marginal land that would be planted. This is a great deal of land, though only 3% of the regional total for forest. It would improve credibility of such analyses if there were a way to identify more specifically where this land is and what it is like.