The past six years have brought us economic recession and a recovery that has been sluggish at best. Unemployment, by some accounts the defining indicator of the public conscience during this time period, while generally better than the national average, has remained persistently high in Virginia by historic standards. Unemployment figures reached a peak of 7.4 percent in December 2009, slowly dropping to 4.9 percent in April 2014, then bounced back up to 5.5 percent by August 2014 (U.S. Bureau of Labor Statistics 2014). The highest levels of unemployment tend to be in rural areas as well as inner-city pockets.

By other accounts, housing starts might be the key economic indicator. It was, after all, the housing sector that triggered the recession in 2008. Building permits for new housing units in the United States dropped from a high of over two million in 2005 to a low of 550,000 in 2009, and rebounded only partially to 920,000 in 2013. (See Figure 1.) This has had a great effect on the market for sawtimber and by extension on private forest landowners. A large proportion of pine sawtimber in the U.S. goes to housing construction. For this reason, pine stumpage, the price that is paid to landowners for standing timber, has dropped drastically since the end of 2005. That year saw pine stumpage prices above $40/ton for sawtimber in much of the U.S. South and in some cases approaching $50/ton. By the fourth quarter of 2014, average pine sawtimber stumpage prices in Virginia were approximately $25/ton (Timber Mart-South 2015). This represents a modest rebound, but still well below prices seen in the 1990s and early 2000s.

By contrast, stumpage prices for pine pulpwood have held relatively steady over this period. Indeed, average Virginia pine pulpwood stumpage prices are over $13/ton (Timber Mart-South 2015) and are continuing an upward trend that seems unfazed by the slow economy. While most industries would expect a reduction in demand and thus a lower market price in a slow economy, pulpwood has bucked that trend.

Certainly, a part of the reason that pulpwood prices remain high is that, in a normal market, sawtimber residuals feed pulpmills, but those are less available when the sawtimber market is down. Furthermore, new regional and international markets for wood chips may help buoy pulpwood prices. In addition to export chips, voluntary renewable energy portfolios in Virginia and nearby states have led some firms to propose new wood-fired electric generating facilities and potentially change existing coal-fired facilities to be co-fired with wood and coal.

In this economic climate, it is reasonable that some landowners might ask if it is not more economically advantageous to grow trees explicitly for pulpwood or chips. Since sawtimber requires larger-diameter logs, a shift to cultivating expressly for pulpwood would imply shorter rotations (fewer years until harvest) and potentially higher plantation densities, meaning that several forest management strategies may have to be approached differently. I utilize a cash flow model to provide insights for recommendations that professional foresters might give to forest landowners.

Here, I estimated potential financial returns of various southern pine plantation silvicultural systems from the...
perspective of family forest landowners, including systems that might be used for pulpwood-only production under the current and potential future pricing regimens, and evaluate what this might mean for landowners and the landscape.

A Look at the Family Forest Landowner

It is important to note that family forest landowners have numerous aspirations for their forestland. Simple timber profit maximization is not the only, and often not the primary, motivation of family forest landowners. Indeed, surveys have shown that motivations such as aesthetics and recreation far outweigh timber production as a reason for owning forest land, at least in terms of number of landowners. Still, to the extent that many landowners operate with budget constraints, one would expect landowners to seek to derive the most income from their property, as long as it is consistent with their other, non-financial motivations.

Newman and Wear (1993) estimated the own-price and cross-price supply elasticities in both the short- and long-term for pulpwood, sawtimber, regeneration costs, growing stock and land. In the short term, a decrease in the price of sawtimber tended to increase the production (supply) of pulpwood, and vice versa, from both industrial and non-industrial private forests (NIPFs). That is, family forest landowners responded in a manner consistent with profit maximization. However, they were somewhat less responsive to price changes than owners of industrial forests, probably because of other non-timber-related objectives for forests (Newman and Wear 1993; Liao and Zhang 2008). On the other hand, in the long term, lower prices for sawtimber and high pulpwood prices was not predicted at that time.

Methods and Models for Management and Valuation

I simulated pine growth and yield using the a model developed by the Department of Forest Resources and Environmental Conservation at Virginia Tech. I used this model, known as PTAEDA 4.0, to estimate growth and returns of loblolly pine on a typical piedmont site (i.e., a site index of 50 ft. at 25 years) based on several possible management regimes. I evaluated the financial outcomes of various management strategies under three plausible price scenarios.

In each of these evaluations, I assumed a starting point of 17-year-old loblolly pines that had been planted using a traditional spacing of 545 trees per acre (TPA). This might represent a typical family forest landowner at a common decision point.

I simulated the growth and yield of several different management

<table>
<thead>
<tr>
<th>TABLE 1. Decision Variables</th>
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<tbody>
<tr>
<td>MANAGEMENT DECISION</td>
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<tr>
<td>What to do at present (age 17)?</td>
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<tr>
<td>If thinned at age 17, what to do at age 25</td>
</tr>
<tr>
<td>After clearcut, density to replant</td>
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<tr>
<td>After clearcut, fertilize?</td>
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<tr>
<td>After clearcut, new rotation length</td>
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<th>TABLE 2. Costs of Management Activities</th>
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<tr>
<td>COST CATEGORY</td>
</tr>
<tr>
<td>Ground broadcast herbicide for site preparation</td>
</tr>
<tr>
<td>Seedlings</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Hand planting cutover land</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Backpack herbicide in 1st year</td>
</tr>
<tr>
<td>Aerial early hardwood release in 8th year</td>
</tr>
<tr>
<td>Establishment fertilization</td>
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<td>Fertilization in 7th year</td>
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</tbody>
</table>

Dooley and Barlow 2013
strategies, and the variables used to determine the various potential management regimes are outlined in Table 1.

First, I considered management activities based on the starting point of 17-year-old trees: clearcut now, or thin now. Doing nothing was not considered a rational option from a silvicultural and deterministic financial standpoint, although from a more nuanced view that takes price variability into account, doing nothing is often optimal.

Once the stand is clearcut, either at age 17, 25, or 35, the landowner faces a decision about the next management plan. These options may include planting at a more traditional spacing of 545 TPA for future sawtimber production versus a more pulpwod-oriented spacing of 1,211 TPA; fertilizing or not; and length of rotation.

Therefore, the management strategy can be described as two decisions: when to clearcut the current stand, and what to replace it with. Each of these basic decisions includes multiple sub-choices.

Management costs

Costs for management activities were derived from Dooley and Barlow (2013). The costs described in Table 2 represent management activities that would be considered fairly typical for cutover family forest land. Establishment costs include ground broadcast herbicide for site preparation, no mechanical site preparation, hand planting loblolly pine seedlings, and one backpack spray herbaceous weed control in the first year. Total establishment costs totaled $169 per acre in the first year for stands planted at 545 TPA. Higher seeding and hand planting costs drove the establishment costs to $220 for stands planted at 1,211 TPA. An aerial early hardwood release was also included for 8-year-old stands planted at 545 TPA.

Stumpage Price Scenarios

Three possible future price scenarios were selected. These were chosen to be plausible future outcomes and to represent a wide range of possibilities. In reality, the future is likely to lie somewhere between these scenarios. Although I have no crystal ball, my personal belief is that these are close to the extremes of likely future prices. Price scenarios are summarized in Table 3 (above) and described below.

It is important to note that my model is structured such that, regardless of the future stumpage price scenario (NN, BB, or CC), the first five years of the model utilize stumpage prices equal to the NN scenario. After five years, the prices switch to the relevant future scenario.

- **New Normal (NN)**
  This scenario assumes that prices stay approximately constant relative to their current levels, in real terms, that is, the current price levels have become the “New Normal.” I utilized stumpage prices of $12/ton for pulpwood, $17/ton for chip-n-saw timber, and $25/ton for sawtimber.

- **Back to Before the Bust (BB)**
  This scenario assumes that, after five years at current prices (same as “New Normal” prices), prices return to approximately what they were during 2000–2005, adjusted for inflation. I utilized stumpage prices of $8/ton for pulpwood, $25/ton for chip-n-saw timber, and $45/ton for sawtimber.

- **Chips are Champs (CC)**
  This scenario assumes that, after five years at current prices (same as “New Normal” prices), pulpwood increases in price relative to sawtimber, possibly due to an increase in demand for wood chips for energy production. Numerous biomass-based or co-fired power plants are being planned in Virginia, but the cumulative effect they will have on prices is not known. Pulwpwood prices would never be equal to or higher than sawtimber because woodchips can easily be made from larger logs, but traditional lumber cannot be made from small logs (although engineered wood products may challenge this assumption in the future). I utilized stumpage prices of $18/ton for pulpwood, $22/ton for chip-n-saw, and $25/ton for sawtimber.

Discount rate scenarios

Three alternative discount rate scenarios were examined:

- 5%, reflecting standard values in forestry literature in most of North America and Europe;
- 10%, reflecting a landowner who may have a higher time preference but able to wait if necessary;
- 20%, reflecting a landowner with an immediate need for income.

Capital budgeting analysis

Growth and yield outputs from the PTAEDA model were used under the various possible management strategies. I observed the most financially profitable strategies under each price scenario within the resulting data spreadsheet.

Future Outlook Based on the Model

Optimal financial decisions for the three price and three discount rate scenarios are in Table 4. Several of the results are quite interesting.

The first decision the hypothetical landowner faces is what to do with the existing 17-year-old stand.
As previously noted, current prices are equal to the NN scenario, then switch to the relevant future stumpage price scenario (NN, BB, CC) after five years. My results showed that the optimal financial decision was much more dependent on discount rate than future stumpage prices. In all except one case (CC 5%), the optimal decision for the current stand followed this trend, regardless of future stumpage price: 5% discount rate – 35-yr rotation; 10% discount rate – 25-yr rotation; 20% discount rate – clearcut now (17-yr rotation).

The most striking result relative to the optimal future rotation is the fact that even under future scenarios with high pulpwood stumpage prices, low sawtimber stumpage, and high discount rates, there was no scenario in which it is an optimal decision to plant at a density of 1,211 TPA instead of the more traditional 545.

This is significant because high-density plantations have been posited as potentially profitable for pulpwood production in times of high pulpwood prices. The reason for this result is two-fold: the higher cost per acre of establishing high-density plantations and the limits to growth caused by increased competition between trees, as simulated in the PTADEA model.

As with the optimal decision for the current 17-yr-old stand, the optimal decision for future management strategies was much more strongly affected by discount rate than by future stumpage price scenarios. At 5% a 35-year rotation is optimal, at 10%, 25-year, at 20%, 17-year. The only variation to this rule was the fact that the CC scenario at 5% discount rate does provide some incentive to harvest earlier than the BB and NN scenarios with the same discount rate. This overarching result, at first glance, may seem improbable.

Also, fertilization was not an optimal decision under any price or discount scenarios. The added growth and yield from fertilization, as simulated in the model, does not justify the additional cost. It should be noted, however, that there are some landowners who are able to access biosolid fertilization at low or zero cost. In that case, the results undoubtedly would be different.

**A Path to Decision-Making**

Optimal financial decisions for pine plantation management was analyzed under two types of scenarios: future stumpage price and discount rate. These two scenarios represent very different factors. Stumpage prices are external to individual landowners—individual landowners are generally price takers and have little control over stumpage prices—while discount rates are internal to the landowner and represent a particular landowner’s propensity to prefer money sooner rather than later.

My analysis showed that even highly variable future stumpage prices have little effect on the optimal decisions that a landowner can make in the present, long before he/she can realize those returns. The factor that does affect the optimal decisions strongly is the discount rate of the particular landowner.

Although future stumpage prices had little effect on optimal stand establishment recommendations, they did have a small effect on rotation length. In this situation, landowners can adopt conventional best establishment methods and a wait-and-see approach.

This all should be comforting to professional foresters who work with landowners. The forester does not need to be able to predict the future of stumpage prices to make sound recommendations at the present. Rather, the forester needs mostly to understand the landowners themselves—their unique preferences and objectives—and the biological
responses of trees to various management strategies.

A finer resolution analysis (more options) would allow for a more precise analysis of small differences in optimal decisions. However, my analysis does allow for a broad understanding of some factors that can have the largest impact on forest management decisions.

Changing markets for timber are likely to continue. Simple capital budgeting models, such as the one utilized here, can help foresters and landowners better understand what forest management regimes may be beneficial. ❉

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References