Financial Feasibility of Selection-Based Multiple-Value Management on Private Lands in the South: A Heuristic Case Study Approach

R. Kevin McIntyre, Steven B. Jack, Barrett B. McCall, and Robert J. Mitchell

ABSTRACT

Over the last 10 years, multiple-value, ecosystem-based approaches to management on public forestlands have become more prevalent. However, less attention has been paid to this concept in the private sector. Although it is recognized that nonindustrial private forest (NIPF) landowners own forestland for a diversity of reasons, information on management approaches that seek to more fully meet multiple objectives is needed, particularly for southern US pine forests. Alternatives to plantation management are available, but little information exists on the economic implications so that NIPF landowners can make informed decisions regarding implementation. This study develops a simple economic model as a heuristic tool to compare financial performance of extensive, multiple-value management approaches. The 50-year projection illustrates that, although not equal to more intensive management systems by some economic performance metrics, multiaged, selection-based alternatives can provide substantial net cash flow, maintain significant timber volume, and have comparable total value.

Keywords: selection silviculture, financial analyses, multiple-value management, private forest landowners, uneven-aged management

Of the approximately 188 million ac of forestland in the South, almost 70% is held in private, nonindustrial ownership (Wear and Greis 2002). Landowner surveys show that in the South, the top-ranked reasons for owning forestland are (1) to pass on to heirs, (2) aesthetics, and (3) land investment (Butler and Leatherberry 2004). These survey results are similar to those collected 10 years earlier (Birch 1996). Both nationally and in the South, timber production ranked lower in the hierarchy of ownership objectives listed by nonindustrial private forest (NIPF) landowners, regardless of whether data are classified by acreage or numbers of owners.

In light of these findings, the prevalence of intensively managed plantations across the South on private lands (Stanturf et al. 2003) is counterintuitive in that the primary objective of plantation systems is to maximize timber production. Although even-aged management can provide benefits in addition to timber production, uneven-aged alternatives to the plantation model may better capture the wider range of values that many people place on forests (Maguire 2005). The continuous forest cover provided by uneven-aged or multiple-aged management systems may, in many cases, be better suited for maintaining the aesthetic qualities, wildlife habitat, asset appreciation, recreational, and other nontimber values that motivate NIPF landowners to own land. Specifically, multiaged management

Received December 15, 2008; accepted August 24, 2009.

R. Kevin McIntyre (kevin.mcintyre@jonesctr.org) is education coordinator, and Steven B. Jack (steve.jack@jonesctr.org) is conservation ecologist, Joseph W. Jones Ecological Research Center, 3988 Jones Center Drive, Newton, GA 39870. Barrett B. McCall (bmccall@larsonmcgowin.com) is president, Larson and McGowin, Inc., P.O. Box 2143, Mobile, AL 36652. Robert J. Mitchell (robert.mitchell@jonesctr.org) is scientist, Joseph W. Jones Ecological Research Center, 3988 Jones Center Drive, Newton, GA 39870. *Funding for this work was provided by the Robert W. Woodruff Foundation. Jessica McCorvey provided proofreading and review. Ruth Seawall and Alexander McCall provided helpful comments.*

using single-tree and small-group selection harvest methods may offer landowners an opportunity to more fully integrate multiple objectives but are underused relative to the potential audience (Farrar 1996).

The use of selection harvest methods and natural regeneration was a more commonly accepted approach to silviculture earlier in the 20th century (O'Hara 2002). Between 1950 and 1999, acreage of natural pine forests in the South declined from over 70 million ac to approximately 33.5 million ac while pine plantation acreage grew from approximately 2 million to 30 million ac (Conner and Hartsell 2002), becoming the dominant form of managed forests in the region (Stanturf et al. 2003).

Today, forestry is an increasingly complex proposition for many private landowners; volatile product prices, industry consolidation and land divestiture, aging mill infrastructure, and globalization of the forest products industry all add increasing degrees of uncertainty about the future of forest management (Franklin 2003, Wear et al. 2007).

At the same time, there is growing recognition regarding the importance of forests in providing critical public goods and services. Water quality and quantity, climate regulation and carbon sequestration, soil stabilization, recreational opportunities, and maintenance of biological diversity are some of the public benefits that forests provide (Myers 1997). Despite increased awareness of their value, the majority of these ecological services are largely nonmarket in nature (Krieger 2001) and although great enthusiasm exists for nascent markets such as carbon, implementation is uncertain and has yet to be achieved at meaningful scales in the United States (Kline et al. 2009). Conservation easements offer the potential to incorporate the value of these nonmarket services by compensating private landowners for their forests' public values through broad ecosystem protection (Kline et al. 2009).

One barrier to wider implementation of alternatives to plantation systems is a lack of economic information that NIPF landowners can use to evaluate potential alternatives. The primary objective of this study was to compare the financial and economic performance of three harvest regimes representative of more extensive, multiple-value approaches to forest management using data from an actual property as a case study. We developed a simple stand projection model to analyze economic outcomes from different levels of selection harvest intensity and compared financial performance, stocking levels through time, and overall asset value. For reference, we also ran a representative plantation management scenario in which the existing timber was liquidated and replanted. As a means of incorporating nonmarket values, we modeled the sale of conservation easements with varying levels of restrictions. Rather than a generalized predictor of future economic returns, the purpose of this model was to provide a heuristic tool for landowners and managers to weigh costs, benefits, and tradeoffs between management options in the context of their land-management objectives.

Methods

The Joseph W. Jones Ecological Research Center is located at Ichauway, a 29,000-ac reserve in southwest Georgia. A 941-ac demonstration forest was delineated on the property to reflect a size and range of conditions commonly found on properties managed for multiple values in the region. The overall goal of the demonstration project is to illustrate forest management that balances multiple objectives, including timber, wildlife habitat, aesthetics, asset appreciation, and conservation values. Another goal is to collect quantitative information on the economics of this approach to management.

The majority of the demonstration forest is dominated by second-growth longleaf pine (*Pinus palustris* Mill.) and mixed pine-hardwood (primarily *Quercus* spp.) forests. As with the larger Ichauway property, the overall goal is maintenance of high-quality longleaf pine forest with associated groundcover where already established and restoration of longleaf where needed. Specific management goals for the property include ecologically sustainable timber production, wildlife habitat for game and nongame species, aesthetics, maintenance of biological diversity, and overall asset appreciation. Prescribed fire is the primary management tool used, with an average 2-year return interval across the property.

An interactive, spreadsheet-based economic model was developed for the tract using Excel software (Microsoft Corp., Redmond, WA). Timber growth, revenues, and expenses were projected for a 50-year time horizon. Initial stocking data were obtained from a standard 10% timber inventory conducted in 2003 by a third-party contractor. Components included in the model are various management activities and assumptions regarding forest growth, revenue, and expenses.

Model Description—Management Activities

Timber. Timber management in the demonstration area is based on a regional variant of the single tree selection method known as the Stoddard-Neel approach (SNA) (Moser et al. 2002, Jack et al. 2006). The SNA was developed on shooting plantations in south Georgia and north Florida over the last 70 years and is noted for integrating wildlife management, prescribed fire, aesthetics, and silviculture into a holistic management system (Mitchell et al. 2006, McIntyre et al. 2008). For this study, three levels of selection harvest intensity were modeled to illustrate a range of results that landowners might expect from using approaches similar to the SNA, both in terms of the financial performance as well as long-term implications for forest growth and structure. The first scenario (low) harvests 80% of the periodic growth between entries. This scenario assumes a stand improvement approach to removals, targeting defective and suppressed trees, or "thinning from below." The second scenario (medium) uses a simple approach of harvesting one-third of the stems in each diameter class. Finally, the last scenario (high) harvests all stems over 21-in. dbh, with improvement thinning in 9- to 21-in. size classes similar to the first scenario. This last strategy is designed to adapt to a trend of mills being unable to handle larger stems. For all three scenarios, half of the forest was harvested every 5 years beginning in year 5, resulting in cutting cycles of 10 years for a given stand. Only the first scenario strictly fits within the framework of the SNA, but the other two scenarios incorporate many of the principles of the approach and deviate primarily in the volume harvested. Although our primary emphasis in this analysis is on the three selection scenarios, for comparison we also modeled plantation scenarios that liquidated existing stock and then managed for 30-year sawtimber rotations, with chemical site prep before planting 650 trees/ac (TPA), and thinnings to 70 ft^2 at 15 and 22 years. Two intensities of liquidation were modeled: an aggressive harvest of 50% of volume at years 1 and 5, and a more moderate approach that removed 50% at years 5 and 10.

Wildlife. Wildlife management activities undertaken on the demonstration forest

Table 1. Ingrowth and mortality assumptions for multiaged management with three levels of selection harvest intensity.

	Low		Medium		High	
Year	Ingrowth No. of 3-in. stems/ac	Mortality Stems (%)	Ingrowth No. of 3-in. stems/ac	Mortality Stems (%)	Ingrowth No. of 3-in. stems/ac	Mortality Stems (%)
1–10	10	0.50	10	0.50	10	0.50
11–20	10	0.50	20	0.50	40	0.50
21–30	5	1.50	10	0.50	20	0.50
31–40	5	1.50	10	0.50	20	0.50
41–50	5	1.50	10	0.50	20	0.50

are similar to those commonly used on recreational properties throughout the region. Small agricultural fields and wildlife openings are maintained to improve habitat for whitetail deer (*Odocoileus viginianus*), wild turkey (*Meleagris gallopavo*), and northern bobwhite quail (*Colinus virginianus*). This is an important component of the overall property management for a landowner, representing either an amenity value or a potential income stream from hunting leases. The structural attributes of relatively open, mature pine-grasslands are recognized for their value as habitat for both game and nongame wildlife (Brennan 1991), supporting the economic valuations assigned to forests with these characteristics.

Model Description—Assumptions

Growth. Forest growth is a key component in the model and for financial projections. Currently, information about the growth and yield for long-term multiaged management of natural longleaf is not readily available in the literature (Guldin 2006). To get around this limitation and still be able to project forest structure into the future, our model uses classic stand table projection methods for estimating future growth (Borders et al. 1987). Previous studies performed in the demonstration area (Mitchell et al. 1999, Battaglia et al. 2003, Pecot et al. 2007) produced basal area growth rates by diameter class. We converted the basal area rates to diameter increments and applied them to the stand table developed from the 2003 timber inventory. The outcome was a working model of stand structure and stem growth by diameter class over time. The key assumption in this approach is that the previous incremental growth rates by diameter class will remain the same going forward with no response to thinning treatments. This is a very conservative approach to growth, and actual yields should improve through time. The plantation scenarios were modeled using the FASTLOB growth-and-yield model (Loblolly Pine Growth and Yield Cooperative, Dept. of Forestry, Virginia Tech.) (Amateis et al. 2001).

Most of the stands in the demonstration forest do not currently have a significant component of regeneration, and ingrowth is critical for long-term sustainability of uneven-aged management (Guldin 2006). The cutting treatments are assumed to improve the quantity of natural regeneration and add a component of ingrowth into the stands over time. Perhaps the weakest assumption in the entire financial projection model, ingrowth is based on regeneration data from the 2003 inventory and then projected by assuming some number of individual 3-in.-diameter stems that enter into the stand table between harvest entries. The model assumes fixed rates of ingrowth and mortality as a function of stand density, with higher harvest intensity scenarios recruiting more ingrowth and experiencing less sapling mortality (Table 1).

Revenue. Revenue projections are derived from two primary sources: periodic timber income and an annual hunting lease for deer, turkey, and quail. The selection harvest regimes outlined in the timber management description mentioned previously resulted in an income pulse every 5 years. Timber values were based on reported stumpage prices for the region in fourth quarter 2005 (Timber Mart-South 2006). Based on long-term historical trends, a 1% real rate of annual appreciation was used for future timber values (South 2009). Return from an annual hunting lease for all game species was included at a rate of $25/ac for selection scenarios and $10/ac for the plantation model given the impact of intensive plantation management on quail (Brennan 1991) and turkey habitat (Kennamer et al. 1980). These figures are consistent with market rates for similar properties in the region as well as with data from willingness-to-pay studies (Hussain et al. 2004). Although many landowners may forgo lease revenue and use their property for their own hunting, this decision represents an opportunity cost that they knowingly assume. To value the broader ecological services that forests provide in the absence of tangible markets accessible to NIPF landowners, we ran an extended analysis of the three scenarios incorporating a third source of revenue from the sale of a conservation easement with tiered restrictions on timber harvest. Conservation easements are voluntary agreements in which landowners agree to give up certain property rights such as commercial development or certain land-management practices in exchange for tax incentives or direct compensation. The property remains in private ownership, with many traditional activities allowed to continue. Although donated easements were historically the norm, purchased easements have now become commonplace as they offer a lower-cost alternative to fee simple public acquisition and management of land (Michael 2003). Easements that permit timber harvest, often referred to as "working forest" easements, have become common, with varying degrees of silvicultural restrictions ranging from broad recommendations to detailed prescriptions (Perschel 2006).

In addition to the sale of development rights at 50% of the bare land value, the low, medium, and high selection harvest scenarios further assumed that the landowner agreed to retain an average standing volume of 4000, 3000, and 2000 bd ft of sawtimber per acre, respectively. The value of these foregone harvests was added to the bare land value to calculate the sale price of the easement in each selection harvest scenario.

Expenses. It was assumed that this scale of ownership would contract for land-management services and standard fees for those services were used in the model. Costs of typical land-management activities were calculated using published data where available (Dubois et al. 1995), as well as market rates common to the region. Overhead and administrative costs include an overall property management fee and a hunt lease management fee calculated on a per acre basis, as well as an 8% commission on periodic timber sales. Ongoing costs such as property taxes; prescribed fire; and maintenance of roads, firebreaks, fences, and wildlife food plots are calculated on a per acre basis (Table 2).

Other Assumptions. The three scenarios, as well as the plantation models, were considered with bare land costs of $800/ac. A 1% real rate of annual appreciation was used for future land values. A discount rate of 6% was used for all calculations, and all figures reflect real values after inflation.

Table 2. Management expenses used in the model projections.

Expense	Cost ($/ac)	Acres (no.)	Acres treated annually (%)
Prescribed fire	10.00	822	50
Food plot maintenance	125.00	105	100
Boundary fire breaks	20.00	941	15
Fences/gates	1.00	941	100
Road work	1.75	941	100
Property management fee	3.00	941	100
Hunt lease management fee	2.50	941	100
Property taxes	10.69	941	100

Costs were determined using typical contracted rates for the region. Annual management costs are calculated from the per acre cost and the number of acres treated per year.

Table 3. Base analysis of projected economic returns under the different management/harvest scenarios.

Harvest scenario	Low	Medium	High
APV ($)	1,297,255	1,470,889	1,589,634
20-yr IRR with land value (%)	3.21	3.29	3.48
Standing volume at yr 0 (mbf)	4,671	4,671	4,671
Standing volume at yr 50 (mbf)	6,009	4,034	2,956
Harvested volume (mbf)	4,794	8,719	11,642
Total accumulated net cash flow ($)	1,796,027	3,732,401	4,986,258
Ending value (land and timber) ($)	4,907,850	3,712,718	3,118,557
Ending total value (cash flow + ending value) ($)	6,703,877	7,445,119	8,104,815

All results are for 50-yr projection except for internal rate of return, which is for 20-yr projection.

Table 4. Analysis of plantation conversion with liquidation of existing timber and subsequent management for 30-yr loblolly sawtimber rotation on the case study property.

Conversion scenario	Moderate	Rapid
APV ($)	1,813,335	2,096,243
20-yr IRR with land value (%)	4.21	5.77
Standing volume at yr 0 (mbf)	4,671	4,671
Standing volume at ye 50 (mbf)	Premerchantable	Premerchantable
Total accumulated net cash flow ($)	5,171,745	4,928,824
Ending value (land and timber) ($)	1,440,467	1,640,605
Ending total value (cash flow + ending value ($)	6,612,212	6,569,429

Results

Base Financial Analysis

The model projection results for the multiaged management scenarios are shown in Table 3, illustrating the range of returns from the three levels of harvest intensity. Metrics that include discounting were average present value (APV; present value over a range of analysis periods) and internal rate of return (IRR; discount rate that results in a net present value [NPV] of zero for a series of future cash flows). These showed relatively minor differences among harvest scenarios. The relative ranking of the scenarios from low to high is predictable, with APV ranging from $1,297,255 to 1,598,634 and a 20-year IRR of 3.21 to 3.48%. Greater differences emerge when cumulative cash flow, standing timber volume, and ending value of the combined timber and land assets are compared, and the results illustrate more complex relationships and tradeoffs between these variables.

In theory, the balance achieved among cash flow, standing volume, and overall asset value should reflect the landowner's desired objectives. In practice, landowners are not always aware of the long-term implications (both for forest structure and financial parameters) of decisions they may make today. For example, although the high harvest scenario brings in almost an additional $3.2 million in cash flow over the 50-year period, standing volume declines through time and total ending asset value is the lowest of the three scenarios (Table 3), suggesting that this scenario might be unsustainable if growth assumptions are correct (O'Hara et al. 2007). In contrast, the low harvest scenario has approximately twice the standing volume and the highest value at the end of the 50-year cycle, but with the tradeoff of significantly lower cash flow.

Plantation Analysis

The results of the two possible conversions to plantations and fixed rotation management are given in Table 4 for comparison. As might be expected, APV and IRR for both plantation approaches outperformed the three selection scenarios. APV for the moderate and aggressive conversions were $1,813,335 and 2,096,243, respectively, with an IRR of 4.21 and 5.77%. The IRR of the aggressive approach is consistent with values reported in the literature for 30-year rotations of planted loblolly pine in the southern United States that include land costs (Cubbage et al. 2007). However, consideration of financial metrics beyond APV and IRR reveals a more complex story. Total value, calculated as accumulated cash flow plus ending land and timber value, is lower for both plantation scenarios than for any of the three selection regimes. In addition, APV for both plantation scenarios, as well as the selection scenarios, is less than the component value (land plus timber) of $2,591,634. This illustrates that use of this single metric for valuation would not support purchase and that prudent landowners likely consider many criteria in the decision process.

Sensitivity Analyses

It is possible to quibble over any of the management cost assumptions shown in Table 2 or with the level of revenues assumed in the model. These assumptions, however, do

Table 5. Sensitivity analysis of financial performance under the different management/harvest scenarios with low (fourth quarter 2008) and high (fourth quarter 2005) timber prices.

	Harvest scenario					
	Low		Medium		High	
Price	Fourth quarter 2005	Fourth quarter 2008	Fourth quarter 2005	Fourth quarter 2008	Fourth quarter 2005	Fourth quarter 2008
APV ($)	1,297,255	979,083	1,470,889	1,109,832	1,589,634	1,196,130
20-yr IRR with land value (%)	3.21	2.78	3.29	2.85	3.48	3.05
Total accumulated cash flow ($)	1,796,027	1,200,757	3,732,401	2,627,297	4,986,258	3,539,497
Ending value (land and timber) ($)	4,907,850	3,928,596	3,712,718	3,083,500	3,118,557	2,698,763
Total value ($)	6,703,877	5,129,353	7,445,119	5,710,797	8,104,815	6,238,260

Table 6. Sensitivity analysis of financial performance under the different management/harvest scenarios with low and high levels of ingrowth.

	Harvest scenario					
	Low		Medium		High	
Ingrowth	Low	High	Low	High	Low	High
APV ($)	1,297,255	1,331,638	1,470,889	1,515,346	1,589,634	1,650,316
20-yr IRR with land value (%)	3.21	3.26	3.29	3.37	3.48	3.59
Standing volume at yr 0 (mbf)	4,671	4,671	4,671	4,671	4,671	4,671
Standing volume at yr 50 (mbf)	6,009	6,539	4,034	6,243	2,956	5,897
Total accumulated cash flow ($)	1,796,027	2,478,058	3,732,401	4,228,527	4,986,258	5,907,537
Ending value (land and timber) ($)	4,907,850	5,294,257	3,712,718	5,101,948	3,118,557	4,980,561
Total value ($)	6,703,877	7,772,315	7,445,119	9,330,474	8,104,815	10,888,098

not have much effect on the relative ranking of the three harvest scenarios but rather scale the results in a linear manner because costs and revenues are fixed over the projection period. Two variables, however, did warrant further exploration. Timber prices might have a nonlinear impact on the financial results because of the differing effects of harvest regimes on residual stand structure and, ultimately, volumes in different product classes. Adequate regeneration to provide ingrowth is another variable that likely interacts with the model results in a nonlinear fashion. To gain insight into the relative effects of these variables, we performed sensitivity analyses using low and high ranges for both variables (Tables 5 and 6). Timber prices were modeled using higher fourth quarter 2005 figures and lower fourth quarter 2008 figures (Timber-Mart South 2006, 2009). Ingrowth was modeled using actual averages from the inventory (low) and doubling those figures (high). High ingrowth numbers were well within the ranges reported in the literature for stands of similar density (Boyer 1993).

Although product prices had significant impacts on financial performance, the impacts generally scale in a linear fashion, with all scenarios showing similar decreases in total value and cash flows using 2008 (low) prices. The model showed a nonlinear sensitivity to ingrowth, however, with greater impacts to cash flow (+38%) in the low scenario and greater impacts to residual timber as a component of ending value in the medium and high scenarios (+37 and +60%, respectively). Indeed, sustainability of the high harvest scenario appears to hinge on the ingrowth variable, with the high harvest/high ingrowth scenario ending with increased standing volume compared with high harvest/low ingrowth (Table 6).

Table 7. Extended analysis of the different management/harvest scenarios with the sale of a conservation easement included in financial projections.

Harvest scenario	Low	Medium	High
APV ($)	2,857,312	2,687,275	2,478,705
20-yr IRR with land value (%)	11.55	8.95	6.80
Standing volume at yr 0 (mbf)	4,671	4,671	4,671
Standing volume at yr 50 (mbf)	6,009	4,034	2,956
Minimum standing volume easement (mbf)	3,764	2,823	1,882
Easement revenue (50% land + restricted timber) ($)	1,865,852	1,479,933	1,111,933
Total accumulated net cash flow ($)	3,661,879	5,212,105	6,088,191
Ending value (land and timber) ($)	4,288,811	3,093,679	2,499,518
Ending total value (cash flow + ending value) ($)	7,950,690	8,305,784	8,597,709

The conservation easement assumed payment for 50% of land value and reserved amounts of standing timber under the different scenarios.

Conservation Easement Analysis

The results of the extended analysis incorporating the hypothetical sale of a conservation easement are given in Table 7. The upfront payment for the easement improves the financial performance dramatically, particularly for discounted metrics. IRR ranged from 11.55 (low) to 6.8% (high) and APV was positive for two of the three scenarios, ranging from $2,857,312 (low) to 2,478,705 (high). The improvement in financial performance was most significant for the low harvest scenario, reversing the relative rankings from the base analysis.

Discussion

This analysis shows that selection harvests are a viable management alternative and can be profitable, albeit with moderate, not maximum, returns. In addition, it suggests that multiaged management may better meet NIPF landowners' objectives as outlined in Butler and Leatherberry (2004). Whether the more immediate financial tradeoffs are balanced by the broader amenities and overall asset appreciation that result from these alternative management approaches is a subjective decision that individual landowners must weigh for themselves. The relative performance of the selection harvest scenarios versus more intensive forms of management for discounted metrics (APV and IRR) in this study is consistent with the range of values reported elsewhere in the literature (Baker 1987, Cafferata and Klemperer 2000).

However, many NIPF landowners do not rely on economic analyses such as NPV and IRR alone to evaluate their land-management decisions (Davis et al. 2001) and present value maximization is often an unsuitable goal when comparing complex multiple-value approaches to management (Klemperer 1996). NIPF landowners typically balance economic returns from timber management with other objectives such as wildlife, recreation, aesthetics, and overall asset appreciation (Birch 1996). These landowners may not consider money spent on land purchase or management as they might other more typical "investments" and they do not track such expenses using standard discounting methods (Emmingham et al. 2002). Of more interest to NIPF landowners are the ongoing costs and benefits of management alternatives at a propertywide rather than stand-level scale. Balanced cash flow and overall financial value of the asset are worthy financial goals in and of themselves for this class of landowner. This analysis suggests that landowners can expect moderate economic returns in the form of cash flow from alternative silvicultural management approaches while maintaining or building residual value in their property.

Comparing the three selection-based scenarios, the medium intensity of harvest offers perhaps the best combination of financial performance and sustainability. This regime would be particularly appropriate for a property that is at or near a desired stocking for other objectives such as wildlife habitat, and understocked stands might be better managed using a lower intensity of harvest with a goal of building volume. The variability of standing volume at year 50 for the high level of harvest in the sensitivity analysis highlights the critical need for better understanding of ingrowth relative to long-term sustainability (Table 6).

One advantage of multiaged selection harvests that this study fails to capture is the ability to adaptively manage forests through time to respond to changing conditions, such as landowners' objectives or volatility in timber markets (Mitchell et al. 2006, Moore and Conroy 2006). Indeed, the liquidity of a multiaged forest comprised primarily of sawtimber is an attribute that many landowners value but one that is difficult to capture analytically. Classic accounting rules typically penalize the liquidity of mature multiaged forests by viewing standing timber as an opportunity cost while ignoring the illiquidity of young plantations.

The sale of a conservation easement with timber harvest restrictions results in dramatic improvements to discounted metrics and more moderate improvements to other financial metrics. Purchased easements that allow ongoing timber management with varying degrees of restrictions and guidelines are common in many regions, with compensation for foregone timber values typically incorporated in these transactions either implicitly (Mashour et al. 2005) or explicitly (Peter Stein, Lyme Timber Company, pers. comm., Aug. 7, 2009). As society recognizes a broader range of values from forests, such as ecosystem services, it is likely that markets will develop to compensate the private sector for the provision of these public goods. Until that time, conservation easements can serve as a practical surrogate that is established, accessible, and that offers a legal and policy basis for application.

One useful result of this modeling work is to highlight information needed to better understand how these systems function, both biologically and silviculturally. Better information is needed on growth and yield for multiaged natural longleaf stands (Guldin 2006, Kush et al. 2006). Although the uncertainty of other variables, such as future interest rates, stumpage prices, and land values, may be equal to the uncertainty of growth assumptions for multiaged stands, the more precise predictability of plantation yields confers an advantage for financial planning. More precise predictive ability would help advance greater acceptance of multiaged management. As the sensitivity analysis shows, the dynamics of regeneration and ingrowth are a critical but poorly understood variable for these systems. How much ingrowth is needed to sustain a given level of harvest? How many seedlings must be captured in regeneration events to sustain a given level of ingrowth? These questions that center around population demographics of multiaged longleaf forests are critical to effective implementation and long-term sustainability of these management approaches (Guldin 2006) and provide a rich research agenda.

Although suggesting that wider implementation is warranted based on landowner objectives, we recognize that extensive management using selection harvest is not a universally viable option for all NIPF landowners and impediments to wider implementation exist. This approach to management can be more complex and time-consuming than traditional plantation management (Farrar 1996, Guldin 2006) and many tracts of land are too small for this harvest regime to be feasible. Still, ownership data suggest that there is a substantial portion of NIPF landowners' acreage that is large enough to consider this form of management. Almost 60% of the NIPF landowners' acreage in the South is in tracts 100 ac or larger (Butler and Leatherberry 2004). Forest inventory data also suggest that there is a substantive land base on which to practice these more extensive approaches to management. Across the South, there are approximately 33.5 million ac of natural pine compared with just over 30 million acs of planted pine. Of the 33.5 million ac of natural pine, over 12.3 million are 38 years of age or older (Conner and Hartsell 2002), suggesting that timber on these acres has reached or exceeded an age that is typically viewed as financial maturity and is being held for its contribution to other objectives. It is also naive to assume that all NIPF landowners strive for an idealistic balance of multiple objectives. For some landowners, one objective may take on much greater importance than others, leading them to determine that more intensive forms of forest management better meet their objectives. For those with larger acreages, using both intensive and extensive management regimes on separate portions of their property may best meet their economic and ecological objectives, particularly when more intensive management is concentrated on higher-quality sites.

Summary

Maximizing economic returns is not typically an objective of a multiple-value approach to management, but revenue from an ecologically sustainable timber harvest program is often a critical component of a financial plan for overall property management. Critics of forest management that more fully balances multiple objectives often cite economic practicality as a barrier to wider implementation. These arguments may be justified as the cost of the inherent tradeoffs are often downplayed or ignored and actual long-term tracking of financial benefits and costs for this type of management is rare. This study and simple model are intended to provide NIPF landowners interested in multiple-value management with a heuristic tool to assess the range of financial outcomes they might expect. It shows that if this type of management meets the landowner's objectives, then revenues are sufficient to support operations and realize a positive cash flow over the long term. The study also highlights the benefits of valuing broader ecological services through the sale of conservation easements. While an imperfect substitute for markets that will likely develop in the future for services such as carbon sequestration or watershed protection, this vehicle is an option that is currently accessible for many landowners. Although the model was intended to address private land ownerships, the results are equally applicable to any forestland ownership in which other management objectives have equal or greater importance than timber production.

Although the results of this study may seem to be fairly straightforward and not surprising in an accounting sense, it is unique from the perspective of looking at the structural response and economic returns over a longer time horizon than is typically examined while also considering a broader range of criteria beyond discounted present values. It is hoped that the insights generated by this work will help NIPF landowners better assess whether alternative management approaches for southern pine forests are appropriate to meet their expressed objectives.

Literature Cited

Amateis, R.L., H.E. Burkhart, H.L. Allen, and C. Montes. 2001. *FASTLOB (a stand-level growth and yield model for fertilized and thinned loblolly pine plantations)*. Available online at www.cnr.vt.edu/g&y_coop/fastlob.pdf; last accessed July 20, 2009.

Baker, J.B. 1987. Production and financial comparisons of uneven-aged and even-aged management of loblolly pine. P. 267–273 in *Proc. of the 4th biennial southern silvicultural research conf.*, Atlanta, GA, Nov. 4–6, 1986, Phillips, D.R. (comp.). US For. Serv. Gen. Tech. Rep. SE-42, Southeast. For. Exp. Stn., Asheville, NC.

Battaglia, M.A., R.J. Mitchell, P.P. Mou, and S.D. Pecot. 2003. Light transmittance estimates in a longleaf pine woodland. *For. Sci.* 49:752–762.

Belin, D.L., D.B. Kittredge, T.H. Stevens, D.C. Dennis, C.M. Schweik, and B.J. Morzuch. 2005. Assessing private forest owner attitudes toward ecosystem-based management. *J. For.* 103(1):28–35.

Birch, T.W. 1996. *Private forest-land owners of the United States, 1994.* US For. Serv. Northeast. For. Exp. Stn. Resour. Bull. NE-134. 183 p.

Borders, B.E., R.A. Souter, R.L. Bailey, and K.D. Ware. 1987. Percentile-based distributions characterize forest stand tables. *For. Sci.* 33(2):570–576.

Boyer, W.D. 1993. Long-term development of regeneration under longleaf pine seedtree and shelterwood stands. *South. J. Appl. For.* 17(1): 10–15.

Brennan, L.A. 1991. How can we reverse the northern bobwhite population decline? *Wildl. Soc. Bull.* 19(4):544–555.

Butler, B.J., and E.C. Leatherberry. 2004. America's family forest owners. *J. For.* 102(7): 4–14.

Cafferata, M.J.S., and W.D. Klemperer. 2000. *Economic comparisons between even-aged and uneven-aged loblolly pine silvicultural systems.* Tech, Bull. 801, National Council for Air and Stream Improvement, Inc., Research Triangle Park, NC. 88 p.

Conner, R.C., and A.J. Hartsell. 2002. Forest areas and conditions. P. 357–402 in *2002 Southern forest resource assessment*, Wear, D.N., and J.G. Greis (eds.).US For. Serv. Gen. Tech. Rep. SRS-53, South. Res. Stn., Asheville, NC.

Cubbage, F., P. MacDonagh, J. Sawinski, R. Rubilar, P. Donoso, A. Ferreira, V. Hoeflich, V.M. Olmos, G. Ferreira, G. Balmelli, J. Siry, M.N. Baez, and J. Alvarez. 2007. Timber investment returns for selected plantations and native forests in South America and the Southern United States. *New For.* 33:237–255.

Davis, L.S., K.N. Johnson, P.S. Bettinger, and T.E. Howard. 2001. *Forest management to sustain ecological, economic, and social values*, 4th Ed. McGraw-Hill, New York. 816 p.

Dubois, M., K. McNabb, T. Straka, and W. Watson. 1995. Costs and cost trends for forestry practices in the south. *For. Farm.* 54:10–17.

Emmingham, W.L., P. Oester, M. Bennett, F. Kukulka, K. Conrad, and A. Michel. 2002. Comparing short-term financial aspects of four management options in Oregon: Implications for uneven-aged management. *Forestry (Oxford)* 75(4):489–494.

Farrar, R.M. 1996. *Fundamentals of uneven-aged management in southern pine.* Misc. Publ. 9, Tall Timbers Res. Stn., Tallahassee, FL. 52 p.

Franklin, J.F. 2003. Challenges to temperate forest stewardship—Focusing on the future. P. 1–13 in *Towards forest sustainability*, Lindenmayer, D.B., and J.F. Franklin (eds.). CSIRO Publishing, Collingwood, Victoria, Australia.

Guldin, J.M. 2006. Uneven-aged silviculture of longleaf pine. P. 217–241 in *The longleaf pine ecosystem*, Jose, S., E.J. Jokela, and D.L. Miller (eds.). Springer, New York.

Hussain, A., D. Zhang, and J.B. Armstrong. 2004. Willingness to pay for hunting leases in Alabama. *South. J. Appl. For.* 28(1) 21–27.

Jack, S.B., W.L. Neel, and R.J. Mitchell. 2006. The Stoddard-Neel approach—A conservation-oriented approach. P. 242–245 in *The longleaf pine ecosystem*, Jose, S., E.J. Jokela, and D.L. Miller (eds.). Springer, New York.

Kennamer, J.E., J.R. Gwaltney, and K.R. Sims. 1980. Habitat preferences for eastern wild turkey on an area intensively managed for pine in Alabama. *Proc. Natl. Wild Turkey symp.* 4:240–245.

Klemperer, W.D. 1996. *Forest resource economics and finance.* McGraw-Hill, Inc., New York. 551 p.

Kline, J.D., M.J. Mazzotta, and T.M. Patterson. 2009. Toward a rational exuberance for ecosystem services markets. *J. For.* 107(4):204–212.

Krieger, D.J. 2001. *Economic value of forest ecosystem services: A review.* The Wilderness Society, Washington, DC. 25 p.

Kush, J.S., J.C.G. Goelz, R.A. Williams, D.R. Carter, and P.E. Linehan. 2006. Longleaf Pine growth and yield. P. 251–267 in *The longleaf pine ecosystem*, Jose, S., E.J. Jokela, and D.L. Miller (eds.). Springer, New York.

Maguire, D. 2005. Uneven-aged management: Panacea, viable alternative, or component of a grander strategy? *J. For.* 103(2):73–74.

Mashour, T., J. Alavalapati, R. Matta, S. Larkin, and D. Carter. 2005. A hedonic analysis of the effect of natural attributes and deed restrictions on the value of conservation easements. *For. Policy Econ.* 7(5):771–781.

McIntyre, R.K., S.B. Jack, R.J. Mitchell, J.K. Hiers, and W.L. Neel. 2008. *Multiple value management: The Stoddard-Neel approach to ecological forestry in longleaf pine grasslands.* Joseph W. Jones Ecological Research Center Publication, Newton, GA. 31 p.

Michael, J.A. 2003. Efficient habitat protection with diverse landowners and fragmented landscapes. *Environ. Sci. Policy* 6:243–251.

Mitchell, R.J., L.K. Kirkman, S.D. Pecot, C.A. Wilson, B.J. Palik, and L.R. Boring. 1999. Patterns and controls of ecosystem function in longleaf pine-wiregrass savannas: I. Aboveground net primary productivity. *Can. J. For. Res.* 29:743–751.

Mitchell, R.J., J.K. Hiers, J.J. O'Brien, S.B. Jack, and R.T. Engstrom. 2006. Silviculture that sustains: The nexus between silviculture, frequent prescribed fire, and conservation of biodiversity in longleaf pine forests of the southeastern United States. *Can. J. For. Res.* 36:2724–2736.

Moore, C.T., and M.J. Conroy. 2006. Optimal regeneration planning for old-growth forest: Addressing scientific uncertainty in endangered species recovery through adaptive management. *For. Sci.* 52(2):155–172.

Moser, W.K., S.M. Jackson, V.V. Podrazsky, and D. Larsen. 2002. Examination of stand structure on quail plantations in the Red Hills region of Georgia and Florida managed by the Stoddard-Neel system: An example for forest managers. *Forestry (Oxford)* 75(4):443–449.

MYERS, N. 1997. The world's forests and their ecosystem services. P. 215–235 in *Nature's services: Societal dependence on natural ecoystems*, Daily, G.C. (ed.). Island Press, Washington, DC.

O'HARA, K.L. 2002. The historical development of uneven-aged silviculture in North America. *Forestry (Oxford)* 75(4):339–346.

O'HARA, K.L., H. HASENAUER, AND G. KINDERMANN. 2007. Sustainability in multi-aged stands: An analysis of long-term plenter systems. *Forestry (Oxford)* 80(2):163–181.

PECOT, S.D., R.J. MITCHELL, B.J. PALIK, E.B. MOSER, AND J.K. HIERS. 2007. Competitive responses of seedlings and understory plants in longleaf pine woodlands: Separating canopy influences above and below ground. *Can. J. For. Res.* 37:634–648.

PERSCHEL, R.T. 2006. *Ensuring sustainable forestry through working conservation easements in the Northeast.* Forest Guild, Santa Fe, NM. 48 p.

SOUTH, D.B. 2009. *Trends in the price of pine sawtimber.* Available online at www.fp.auburn.edu/sfws/sfnmc/web/stumpage.html; last accessed July 27, 2009.

STANTURF, J.A., R.C. KELLISON, F.S. BROERMAN, AND S.B. JONES. 2003. Innovation and forest industry: Domesticating the pine forests of the southern United States, 1920–1999. *For. Policy Econ.* 5:407–419.

TIMBER MART-SOUTH. 2006. *Timber Mart-South home page.* Available online at www.tmartsouth.com/; last accessed Jan. 12, 2006.

TIMBER MART-SOUTH. 2009. *Timber Mart-South home page.* Available online at www.tmartsouth.com/; last accessed July 24, 2009.

WEAR, D.N., AND J.G. GREIS. 2002. *Southern forest resource assessment: Summary report.* US For. Serv. Gen. Tech. Rep. SRS-54. 103 p.

WEAR, D.N., D. CARTER, AND J. PRESTEMON. 2007. *The US South's timber sector in 2005: A prospective analysis of recent change.* US For. Serv. Gen. Tech. Rep. SRS-99. 29 p.