



Bugs, Budgets, Mergers, and Fire: Disturbance Economics

Proceedings of the 2003
Southern Forest Economics Workers
Annual Meeting

March 17 & 18, 2003
New Orleans, Louisiana

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Table of Contents

	Page
Concurrent Session	
IA. Timber Price and Risk	
Examining Timber Price Volatility and Risk Matthew H. Pelkki	1
Pine Sawtimber Severance and Price: A Causality Test for Louisiana Doleswar Bhandari, Sun Joseph Chang, and Michael A. Dunn	11
Southern Softwood Trends from a Timber Mart-South Perspective Thomas G. Harris, Jr. Joshua Harrell, Sara Baldwin and Jason Little.....	21
Potential Application for Weather Derivatives in Managing Supply Risk Brooks C. Mendell, Michael L. Clutter, and David H. Newman	28
IB. Markets and Impacts	
Complexities of Hardwood Roundwood Supply and Demand William Luppold and Matthew Bumgardner	30
The Effects of Mississippi's Transportation Network on Forest Management and Production Forestry D. Paul Gilliland, Donald Grebner, William Stuart, and Laura Grace	39
Note: Full Text found on page	377
Econometric Analysis of United States Paper Supply, 1981- 2001 Roger Brown and Daowei Zhang	40
Error Correction Models and Directed Graphs of U.S. Newsprint Demand Metha Wongcharupan and Peter J. Ince	47
Land Use Change Determinants by Ownership and Forest Type in Alabama and Georgia Rao V. Nagubadi and Daowei Zhang	56
IC. Sustainable Forest Management & Certification	
Global Status and U.S. Costs of Forest Certification Thresa Pressley, Frederick Cubbage, and Jacek Siry	68
Who Owns World's Forests? Implications for Forest Production, Management, and Protection Jacek P. Siry and Frederick W. Cubbage.....	77

The Costs of BMP/SFI Compliance: Arkansas Loggers' Perspectives Sayeed R. Mehmood, Matthew Pelkki, and Rebecca Montgomery	85
Forest Stewardship Council Certification Conditions, Management Impacts, and Costs for NC State University College Forests Allan Marsinko, Frederick W. Cubbage, Joe Cox, and Susan Moore	95
ID. Taxes and Policy	
An Evaluation of Forest Property Tax Programs in the United States Julie Rodenberg, Michael Jacobson, and Mark McDill.....	106
Southern Forest Sustainability and Local Government: Cases in Perverse Incentives Michael Mortimer and Dylan Jenkins.....	107
Land Trust Activity and Property Tax Assessment in Georgia Columbia L. Mecham and David H. Newman	119
An Evaluation of Georgia's Conservation Use Valuation Assessment Program David Newman, Dawn Black, and Coleman Dangerfield	127
A Comparative Analysis of Industrial Timberland Property Taxation in the US South Guiping Yin and David Newman	128
IE. Social Forestry	
Female Forestland Owners: Characterizations of Assistance Needs Sarah Day Crim, Mark Dubois, Conner Bailey, and John Schelhas.....	129
Determinants of Landowner Participation in the Safe Harbor Program Sayeed R. Mehmood and Daowei Zhang	140
Community Choices and Housing Decisions: A Spatial Analysis of the Southern Appalachian Highlands Seong-Hoon Cho, David H. Newman, and David N. Wear	141
Understanding Public Preferences for Alternative Silvicultural Systems Using Mixed Logit Models Thomas P. Holmes and Elizabeth Murphy	160
IIA. Stand-Level Management	
Forest Management Activities and Expenditures of Mississippi NIPF Landowners: 1998- 2000 Data Kathryn G. Arano and Ian A. Munn	161

Financial Evaluation of Thinning and Pruning Silvicultural Treatments on a Thirty Year Rotation of Old Field Pine Plantation in North Louisiana Michael A. Dunn and Terry R. Clason	176
The Effect of Relative Product Prices on the Optimal Management of Lobolly Pine James E. Henderson and Ian A. Munn.....	188
IIB. Timber Harvesting	
Computer Simulation Model for Assessing Wood Procurement Practices in the Southeastern United States William H. Howell and Michael L. Clutter	194
Examining the Performance of Independent Harvesting Firms in the Eastern United States Brian D. Jackson, William B. Stuart, Laura A. Grace, and Andrew J. Londo	195
A Discussion of Antitrust Implications for Future Horizontal Merger Activity within the Tissue Industry Seth Cureington and Sun Joseph Chang	203
IIC. Forest Recreation and Impacts	
An Economic Feasibility Study for Recreational Development on the Bienville National Forest in Mississippi Stephen C. Grado, Donald L. Grebner, Rebecca O. Drier, and Ian A. Munn	211
Modeling the Demand for and Value of OHV Recreation in Tennessee Charles B. Sims, Donald G. Hodges, Burton English, et al.....	221
Economic Impact of the Proposed Marvin Nichols I Reservoir to the Northeast Texas Forest Industry Weihuan Xu	231
IID Models and Forecasts	
Effect of Stochastic Prices on Intensive Management Treatment Scenarios and Collective Harvesting Decision by NIPF Landowners Tymur Sydor, Michael Clutter, and David Newman.....	240
Nonstationarity and Its Consequences in Modeling the Southern Timber Market Nianfu Song and Sun Joseph Chang.....	241
How Low Can We Go?: Southwide Projections with Low Demand Bob Abt.....	251

II.E. International Forest Management

The Global Forest Products Model (GFPM): Structure, Estimation, and Applications Joseph Buongiorno, S. Zhu, D. Zhang, J. Turner, and D. Tomberlin.....	252
---	-----

The Influence of Regulatory Forest Policy Tools on the Biodiversity of Woody Vegetation in Ukraine Maksym Polyakov and Lawrence Teeter.....	263
---	-----

Interest Groups and the Softwood-Lumber Dispute Brooks C. Mendell, Michael L. Clutter, and Carol Hyldahl.....	271
--	-----

IIIA. Forest Finances

Assessment of the Profitability of Intensive Silvicultural Treatments in the U.S. Pulp and Paper Industry Rafael De La Torre and David Newman	273
---	-----

Information Systems Manager, Evergreen Timberland Investment Management, a Wachovia Company Jefferson H. Mayo.....	274
--	-----

Financial Returns from Plantations Established Through the Conservation Reserve Program in Arkansas R.A. Montgomery, M.H. Pelkki, and R.A. Williams	275
---	-----

IIIB. Milling

Regional Differences in the Timber Resources and the Sawmill Industry in Pennsylvania William Luppold, Paul M. Smith, and Sudipta Dasmohapatra.....	279
--	-----

Southern Forest Products Association 2001 Annual Mill Survey Wade Camp.....	286
--	-----

Total Factor Productivity Measurement with Improved Index Numbers SoEun Ahn and Bob Abt	287
--	-----

IIIC. Fire

Wildland Fires: What to Blame? Jianbang Gan.....	298
---	-----

A Predictive Model of Wildland Arson Ignitions Jeffrey P. Prestemon and David T. Butry	309
---	-----

Estimating the Value of Fuels Treatment on Colorado's Front Range Susan H. Howell and Douglas B. Rideout.....	310
--	-----

IIID. Agroforestry

Florida Ranchers' Willingness to Adopt Silvopasture Practices: A Dichotomous Choice Contingent Valuation Approach Ram K. Shrestha and Janaki A. Alavalapati.....	317
--	-----

Grazing Conservation Tillage Corn with Steers in an Agroforestry Environment: Advantages for Land Owners, Wildlife, and Timber Producers Michael Boyd, Glover Triplett, David Lang, et al.	330
---	-----

IVA. Finances

An Analysis Process Used to Stratify Timberland Management Compartments Within an Ownership Based on Long-Term Earning Potential Anthony J. Cascio	331
--	-----

Applying Modern Portfolio Theory to Timberland Allocation Bruce Carroll.....	339
---	-----

IVB. Regional Impacts

Impacts of Inaccurate Area Estimation on Harvest Scheduling Using Different Image Resolutions Nathan Renick, D. Grebner, D. Evens, I. Munn, et al.	350
---	-----

Incorporating Interstate Trade in a Multi-region Timber Inventory Projection System Lawrence Teeter, Maksym Polyakov, and Xiaoping Zhou.....	359
---	-----

IVC. Fire

Native Americans and Montana Residents Willingness-to-pay for Fire Prevention Programs Armando Gonzales-Caban, John B. Loomis, and Hayley Hesseln.....	372
--	-----

Optimizing Fuels Management for Wildfire Risk Reduction in Florida Evan Mercer, J. Prestemon, D. Butry, J. Pye, T. Holmes, and K. Abt	373
--	-----

Cost Function Estimates for Large Fires Karen L. Abt, Robert J. Huggett, and Jeffrey P. Prestemon	374
--	-----

IVD. Valuing the Resource

Decision Methods for Forest Resource Management J. Buongiorno and J.K. Gilles	375
--	-----

Trees in Residential Landscape – A Hedonic Study of Property Valuation Tymur Sydor, David Newman, Mike Bowker, and Ken Cordell	376
---	-----

Preliminary Study on the Effects of Transportation on Forest Management and Production Forestry in Mississippi D. Paul Gilliland, Donald L. Grebner, William B. Stuart, and Laura A. Grace	377
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Papers from the 2003 Southeastern Economic Association Meeting

Evaluating Forest Management Intensity Among Major Landowner Groups in Mississippi: A Preliminary Analysis Kathryn G. Arano and Ian A. Munn	385
Economic Impact of Commerical Hunting Outfitters and Clientele in Mississippi James E. Henderson, Stephen C. Grado, and Ian A. Munn	397
From Senators to the President: Solve the Lumber Problem or Else Daowei Zhang and David Laband	403

Examining Timber Price Volatility and Risk

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Abstract: Stumpage prices for timber are highly volatile due to short-term supply changes. Forest landowners are very sensitive to changes in timber stumpage and often gauge their willingness to invest in timber production by asking about the outlook for markets and prices for timber. Hardwood and softwood sawtimber and pulpwood price series were examined in various southeast markets from 1955 to 2002. Timber price changes during 1-, 5-, 10-, 15-, 20-, and 30-year periods were determined to model price volatility. Short-term (< 5 year) price declines can be severe, but the likelihood of real price increases has been typically better than 70% for intermediate time frames (10 - 15 years) and better than 90% for long time frames (> 20 years). This data can be used to explain the nature of risk posed by timber price volatility.

INTRODUCTION

Part of the recent downturn in the United States' economy has been a general decline in timber stumpage prices in the South from 1997-2002. The mild recession and slow growth of the United States economy, combined with overcapacity in many areas of the U.S. and Canadian wood and paper products manufacturing sectors (Forestweb 2002) has led to lower demand and prices for stumpage. This trend, demonstrated in Figure 1, is cause for some concern for landowners accustomed to steadily rising prices throughout the decade of the 1990's.

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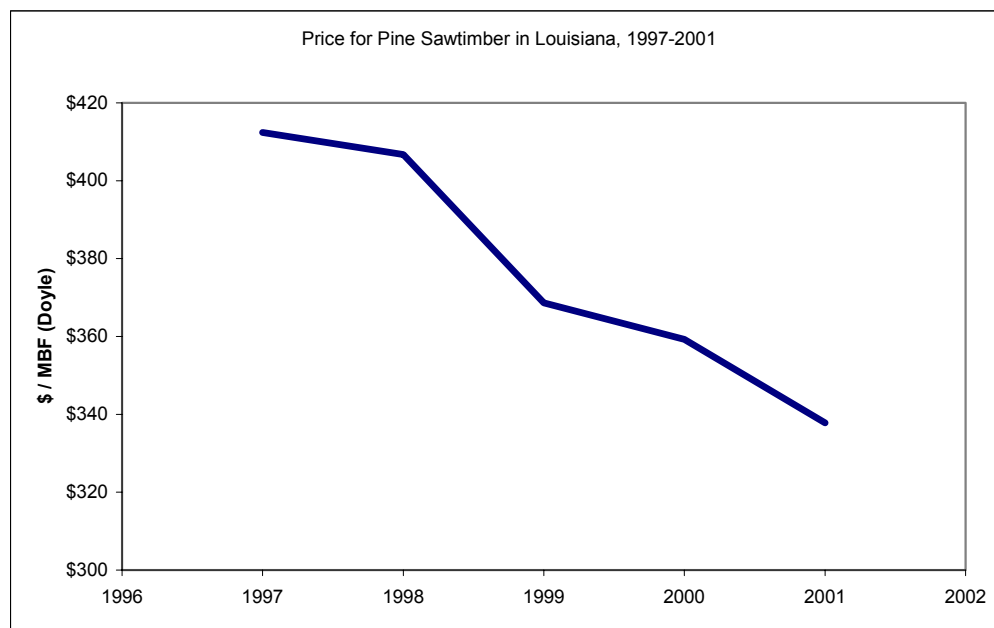


Figure 1. Louisiana statewide average pine sawtimber stumpage prices from 1997-2001.

Forest landowners are very sensitive to a stumpage price decline; it influences their willingness to reinvest in timber after harvesting and to enhance existing forest stands through silvicultural activities. Like most people, even short-term price declines are sufficient to create adverse investment conditions for landowners, sustained price declines such as that shown in Figure 1 is a cause for major concern among forestland owners in the mid-Gulf states.

Thoughts on Long-Term Outlook for U.S. Timber Demand

There are significant reasons to be less than optimistic about the future of timber prices in the Southern United States. Forest industry is continuing to divest itself of marginal lands and is reducing capacity (McLaren 2002a, c) in an attempt to boost profits (McLaren, 2002b). Capital expenditures for in the forest industry sector dropped steadily in 2002 (Jensen, 2002a, b), indicating that the industry does not anticipate growth in demand in the near future.

Long-term projections are also less than optimistic for the forest products industry. The 2002 RPA Assessment (Haynes 2003) looks for a slower increase in the use of wood products in the United States and subsequently, a slower growth in the increase in stumpage prices. Real or inflation adjusted sawtimber stumpage prices are predicted to increase by only 0.5% per year nationally (comparing to 1.9% per year from 1950-2000).

However, the report also predicts that consumption will increase by 40% over the next fifty years. The relatively cautious outlook on stumpage prices is made under the assumption that supply from private forests will continue to increase, harvest restrictions on private forestland will be minimal, imports will nearly double, and recycled or recovered wood use will also nearly double.

This paper offers no analytical rebuttals to these claims, but recognizes the historical strength of the demand for wood products in the United States. The population of the United States, as it has become more affluent has shown a great willingness to increase its use of forest products over the last fifty years. As of 1999, the United States consumed 26.6% of the world's industrial roundwood, and per capital, U.S. consumers used nearly six times the world average of industrial roundwood per year (FAO 2003). Clearly, policies concerning timber production and consumption in this country will largely determine future stumpage prices.

Other future scenarios are just as likely as Haynes' (2003) predictions. It is possible that harvesting restrictions will reduce domestic supply from private forestlands over the next fifty years, pushing stumpage prices higher. Population growth in the United States is a combination of natural fecundity and immigration, both will be needed to increase over the next twenty years to meet shortages in labor supply as the "baby boom" generation in the United States leaves the working force for retirement. With increased affluence and a more urbanized population, demand on U.S. forests for living space, recreation, and non-timber or timber-conflicting uses could increase demand for timber available for harvest.

In an effort to provide some simple tools for foresters to use to explain timber price volatility to landowners and demonstrate the nature of timber price fluctuations and long-term price changes, timber stumpage price data from the state of Louisiana was analyzed for the period of 1955-2001. While it would be prudent to recognize that the future may not reflect the past, this data can be used to explain the nature of short-term (< 10 years) and long-term (> 10 years) risk in timber investments for landowners.

METHODS AND DATA

Stumpage price data was obtained from the State of Louisiana's web site (Louisiana 2003). Data for pine and hardwood sawtimber and pulpwood are available regionally within the state through the original reports, for this study, only the statewide average prices were used.

Price changes were calculated for different time periods (1-, 5-, 10-, 15-, and 30-years) for the entire historical series, from the third quarter of 1955 to the first quarter of 2002. The annual compound percentage price change was calculated using the formula:

$$i = \left(\sqrt[n]{\frac{P_{t+n}}{P_t}} - 1 \right) 100$$

where i = compound annual interest rate
 n = number of years between prices
 P = statewide average price

Since the data is quarterly, the prices were compared quarter to quarter, so for each year, four estimates of the compound rate of price increase were obtained.

The data were aggregated into eight categories of annual price rate change and were plotted on "risk" histograms that show the likelihood or risk of an annual average price increase or decrease over various time periods. The annual data were also plotted directly to examine the volatility of prices over this period.

Results and Discussion

Table 1 shows the data for the histograms for pine sawtimber, pine pulpwood, hardwood sawtimber, and hardwood pulpwood. To save space, only the pine sawtimber risk histograms are included in this paper, they are shown in figures 2-6.

As can readily be seen from table 1 the likelihood of price decreases is significant over 1-year and 5-year time horizons. Pine sawtimber prices have declined in about one third of previous 1-year (36%) and five-year (29%) periods. Data for hardwoods shows a similar pattern for 1-year periods, but risk of price declines in hardwoods over 5-year periods is lower, about 1 in 10 for both sawtimber and pulpwood.

Risk of price declines drops rapidly as holding periods increase in length. Again, based on historical data, price declines for pine sawtimber have a 1 in 10 chance (9%) over 10-year holding periods, a 1 in 50 chance for pine pulpwood, and a 1 in 100 chance for hardwood sawtimber or pulpwood. History demonstrates that in no cases have prices declined over 15-year or 30-year time horizons.

Another gauge of performance is the average rate of price change over various time periods, as shown in table 2. This table reflects the high rate of stumpage price increases in the Gulf States region over the latter half of the 20th Century. However, averages do not provide any information about risk.

Table 1. Frequency of annual price changes in Louisiana stumpage prices from 1955 to 2002 by 1-, 5-, 10-, 15-, and 30-year periods.

Product	Time Period	Frequency (percent) of periods with annual rates of price change in the following categories (negative prices are shaded)							
		< -20%	-20 to -10 %	-10 to -5 %	-5 to 0%	0 to 5%	5 to 10%	10% to 20%	> 20%
Pine sawtimber	1 yr	6	8	8	14	12	12	19	21
	5 yrs	0	2	4	23	14	14	41	2
	10 yrs	0	0	0	9	26	31	34	0
	15 yrs	0	0	0	0	32	53	15	0
	30 yrs	0	0	0	0	9	91	0	0
Pine pulpwood	1 yr	2	7	3	13	35	15	16	9
	5 yrs	0	0	1	14	43	24	17	0
	10 yrs	0	0	0	2	49	37	12	0
	15 yrs	0	0	0	0	45	53	2	0
	30 yrs	0	0	0	0	30	70	0	0
Hardwood sawtimber	1 yr	2	9	9	10	18	14	16	22
	5 yrs	0	0	0	7	27	31	31	4
	10 yrs	0	0	0	1	20	46	34	0
	15 yrs	0	0	0	0	9	78	13	0
	30 yrs	0	0	0	0	3	97	0	0
Hardwood pulpwood	1 yr	6	7	7	9	23	18	19	13
	5 yrs	0	0	2	10	37	36	13	2
	10 yrs	0	0	0	1	41	48	10	0
	15 yrs	0	0	0	0	33	65	2	0
	30 yrs	0	0	0	0	32	68	0	0

Table 2. Average compound annual rate of stumpage price changes in Louisiana timber, 1955-2002.

Product class	Average compound rate of stumpage price change by time horizon				
	1-year	5-years	10-years	15-years	30-years
Pine sawtimber	6.5	6.4	7.0	7.0	6.8
Pine pulpwood	4.6	4.5	5.0	5.3	5.4
Hardwood sawtimber	9.0	8.0	8.3	7.8	7.7
Hardwood pulpwood	6.4	5.5	5.9	5.8	5.8

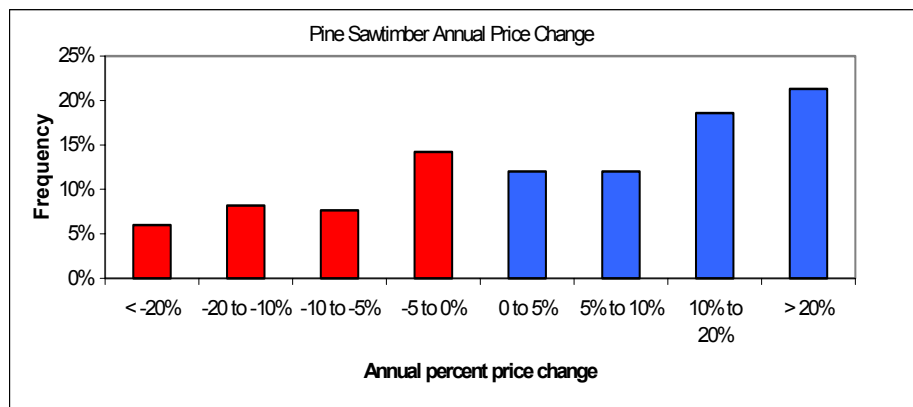


Figure 2. Frequency of annual price change rates over 1-year periods in Louisiana pine sawtimber, 1955-2002.

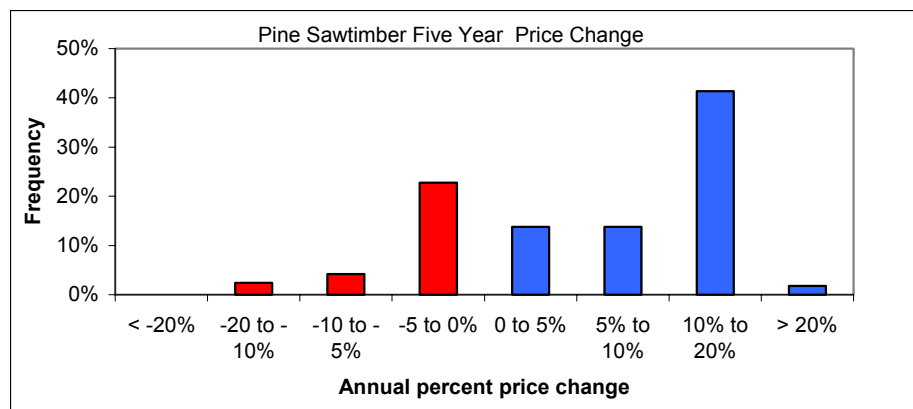


Figure 3. Frequency of annual price change rates over 5-year periods in Louisiana pine sawtimber, 1955-2002

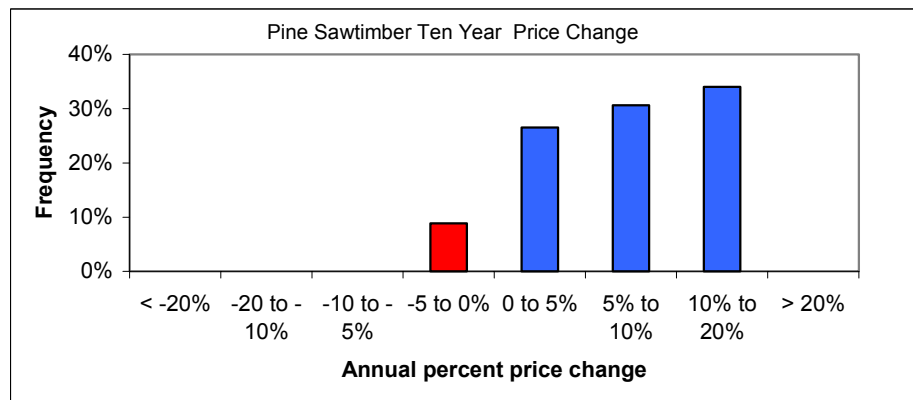


Figure 4. Frequency of annual price change rates over 10-year periods in Louisiana pine sawtimber, 1955-2002

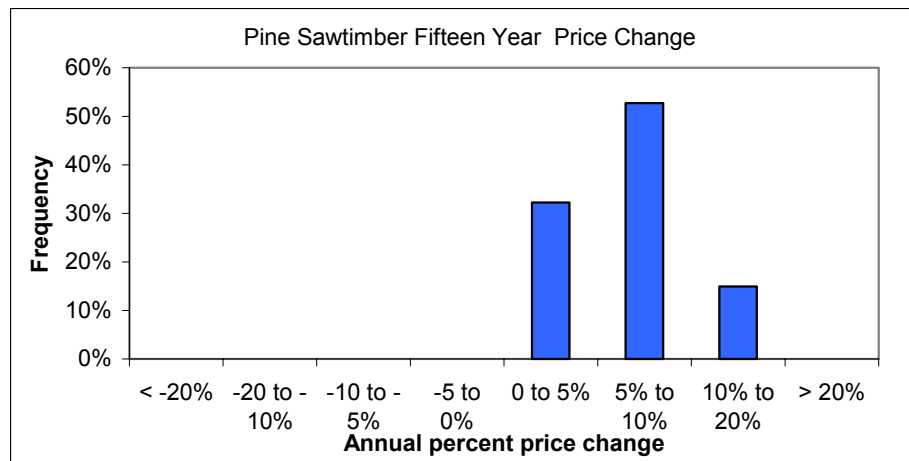


Figure 5. Frequency of annual price change rates over 15-year periods in Louisiana pine sawtimber, 1955-2002.

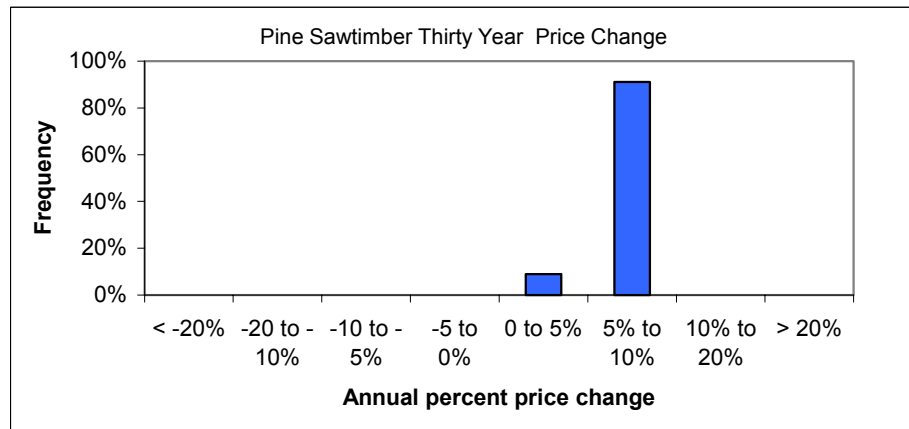


Figure 6. Frequency of annual price change rates over 30-year periods in Louisiana pine sawtimber, 1955-2002.

Table 3 shows the likelihood of average compound interest rates exceeding that of inflation, which averaged 3.5% per year during the period of 1955-2002. We can see that as the holding period increases, the likelihood that timber will provide a good hedge against inflation increases

While the historical data seems to indicate low risk in timber investments due to price declines, the data do appear to indicate that volatility in timber prices has changed for pulpwood markets. Figures 7-10 plot the average annual stumpage prices for each quarter for pine and hardwood sawtimber and pine and hardwood pulpwood. In the sawtimber markets (figures 7 and 8), annual price fluctuations appear to remain the same for pine sawtimber (-20% to +40%) and for hardwood sawtimber (-10% to + 40%). But in pine

Table 3. Frequency of average stumpage price increases exceeding rate of inflation by product class and length of holding period in Louisiana, 1955-2002.

Product class	Percentage of time periods where annual compound rate of stumpage price increases exceeded average rate of inflation				
	1-year	5-years	10-years	15-years	30-years
Pine sawtimber	54%	62%	72%	92%	100%
Pine pulpwood	48%	46%	67%	71%	70%
Hardwood sawtimber	58%	76%	90%	98%	98%
Hardwood pulpwood	52%	60%	77%	86%	94%

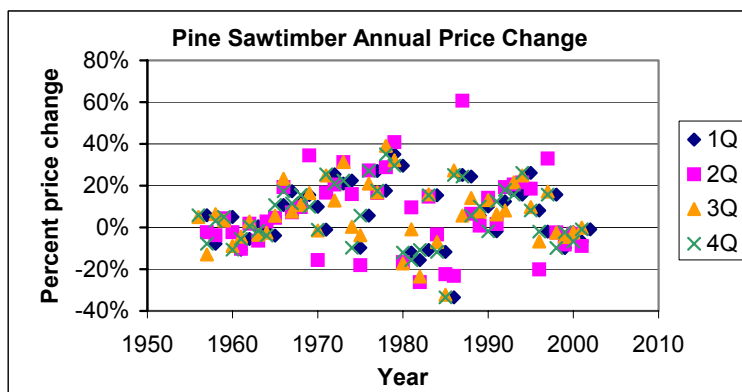


Figure 7. Pine sawtimber stumpage annual price changes in Louisiana, 1955-2002.

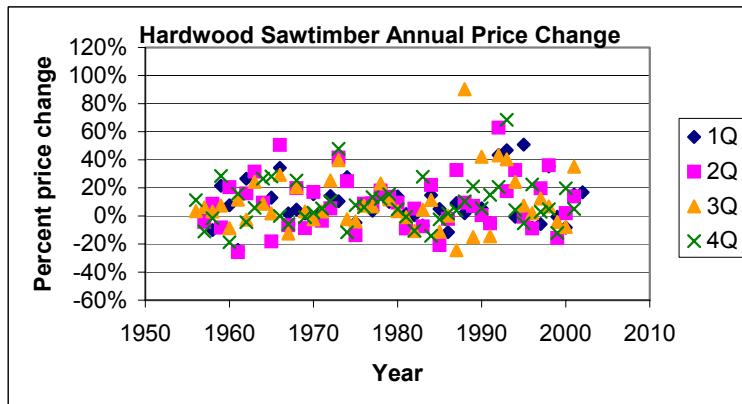


Figure 8. Hardwood sawtimber stumpage annual price changes in Louisiana, 1955-2002.

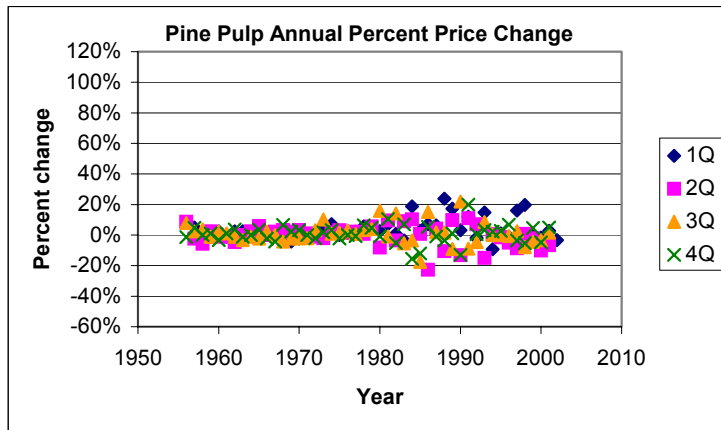


Figure 9. Pine pulpwood stumpage annual price changes in Louisiana, 1955-2002.

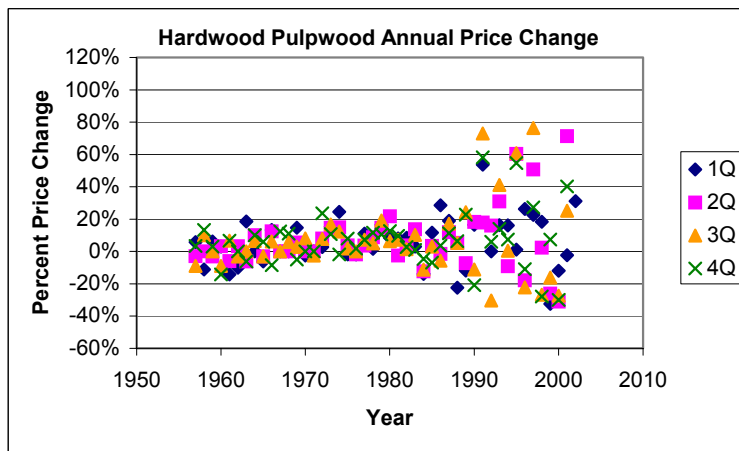


Figure 10. Hardwood pulpwood stumpage annual price changes in Louisiana, 1955-2002.

pulpwood, the annual price fluctuations increased in 1980. Prior to 1980, annual price changes for pine pulpwood were -10% to $+10\%$. After 1980, the price changes ranged from -20% to $+20\%$ (figure 9). A similar change occurred in hardwood pulpwood in the 1990's, but the price fluctuations in the hardwood pulp market were even more dramatic (figure 10). Possible causes for great price volatility in the pulpwood markets may relate to changing technology, the entry (and exit) of chipmills and export markets, and harvesting restrictions for water quality and environmental protection.

Historical timber price data can be used to explain to forest landowners the nature of timber price volatility and risk. Based on this data, it appears that the market-caused risk for timber investments has been very low over the last fifty years if landowners are willing to hold timber for at least 10 years. Since the shortest pulpwood rotations in the South are greater than five years, and typically 10- to 15-years, risk of long-term declining prices has been historically low. However, the data indicates that landowners may have to tolerate higher levels of price fluctuations in pulpwood markets and be more

aware of the factors that might suppress or increase prices actually paid for their pulpwood stumpage. It should also be noted that the future of timber stumpage prices might not be reflected in the historical record; there are good reasons to believe that timber price increases in the future may be moderated by reduced consumption, recycling, and imports.

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Pine Sawtimber Severance and Price: A Causality Test for Louisiana

Doleswar Bhandari¹, Sun Joseph Chang², and Michael A. Dunn¹

Abstract: Industrial and non-industrial private forests account for about 95 percent of pine sawtimber supply in Louisiana. For these forest landowners, do past prices affect the present supply of timber? On the other hand, can past quantities of timber severed affect the current stumpage price? This study tries to answer these questions with the Granger causality test.

According to Granger's causality, stumpage price causes timber quantity severed if we can better predict the current timber quantity severed with both past timber quantities severed and stumpage prices than with just past timber quantities severed alone. Conversely, timber quantity severed causes stumpage price if we can better predict the current stumpage price with both past stumpage prices and timber quantities severed than with just past stumpage prices alone. Granger causality tests were applied to quarterly data from the first quarter of 1984 to the third quarter of 2001 on quantities of pine sawtimber severed and average stumpage prices obtained from the Louisiana Department of Agriculture and Forestry. The ordinary least squares (OLS) procedure was utilized for these analyses. Results showed that past quantities severed caused the current price and past prices caused the current quantity severed. As such a feedback loop exists between quantity severed and price. This result implies that the pine timber market in Louisiana is competitive and efficient.

Key Words: Granger causality test, pine sawtimber, stumpage price, timber quantity

severed

INTRODUCTION

Pine sawtimber accounts for about 80 percent of the sawtimber harvest in Louisiana. About 95 percent of the pine sawtimber was harvested from both industrial and non-industrial private forestland. Private forest landowners, acting rationally, take into consideration stumpage prices from the past in making current timber harvest decisions. For the market as a whole, do timber harvests that have occurred in the past affect current stumpage price? Effects of past prices obtained by private forest landowners and past quantities of timber severed on present price and quantity of timber severed in Louisiana have not been studied. In this study we examined the direction of causality between quantity severed and price of pine sawtimber as follows.

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Approved for publication by the Director of Louisiana Agricultural Experiment Station as manuscript 03-40-1491

- a) Does quantity cause price or
- b) Does price cause quantity or
- c) Is there a feedback from both or
- d) Are both independent?

LITERATURE REVIEW

According to Granger (1969), the time series X is said to “cause” Y relative to the Universe U (U includes both X and Y as components) if and only if the current value of Y can be better predicted with past values of both X and Y than Y alone. Based on this definition, Geweke (1982) developed a direct test for causality by first running the following regression equations

$$Y_t = a_{10} + \sum_{j=1}^p a_{1j} Y_{t-j} + \varepsilon_{1t} \quad (1)$$

$$Y_t = a_{20} + \sum_{j=1}^p a_{2j} Y_{t-j} + \sum_{k=1}^q b_{2k} X_{t-k} + \varepsilon_{2t} \quad (2)$$

where ε_{1t} and ε_{2t} are regression residuals; a_{1j} and a_{2j} are parameters relating Y_t and its lagged values; and b_{2k} are parameters relating Y_t to past values of X_t . Geweke’s direct test of Granger’s causality involves testing the null hypothesis:

$$b_{21} = b_{22} = \dots = b_{2q} = 0 \quad (3)$$

which can be effectively carried out with a Chow F test.

Granger’s causality test was utilized by many people in the past in agricultural economics. Notable literatures on this topic include Zapata and Gil (1999), Zapata and Rambaldi (1997), Milijakovic and Garcia (1996), Bach and Nuppenau (1996), Schimmelpfennig and Thirtle (1994), Weersink, and Tauer (1991), Sarker (1990), and Bessler and Brandt (1982). In forestry, past studies include articles by Chang (1983) and Buongiorno and Brannman (1985). Formulation of theoretical model

Rational expectation theory forms the basis for this causality test. This theory postulates that economic variables (in our case quantity harvested and price) are generated by systematic processes. Over time, economic agents learn what the process of determining a variable is, and they will use this knowledge to form expectations of that variable. Buyers and suppliers learn about how much to buy and sell by using available information. Let S_t be the quantity of pine sawtimber severed, P_t its price and S_t^* the desired quantity of severance ($S_t^* = \beta P_t$). The partial adjustment model (PAM) says that the actual change in quantity of severance ($S_t - S_{t-1}$) is only a fraction (γ) of the desired change ($S_t^* - S_{t-1}$), that is

$$S_t - S_{t-1} = \gamma (S_t^* - S_{t-1}) + u_t \quad \text{with } 0 < \gamma < 1 \quad (4)$$

$$S_t - S_{t-1} = \gamma (\beta P_t - S_{t-1}) + u_t \quad (5)$$

$$S_t = \gamma \beta P_t + (1 - \gamma) S_{t-1} + u_t \quad (6)$$

$$S_t = b_1 P_t + b_2 S_{t-1} + u_t$$

(7)

With $\gamma \beta = b_1$ and $1 - \gamma = b_2$, equation 7 can be estimated econometrically as

$$S_t = b_0 + b_1 P_t + b_2 S_{t-1} + u_t$$

(8)

The rational expectation of S_t in period t is its mathematical expectation given the available information. This theoretical model is generalized using Granger's causality definition.

Geweke's ordinary least squares regression is a specific causality test based on Granger's definition. There are four kinds of causal relationships between price and quantity severed. One of the directions is that price causes quantity severed as suggested by economic theory. Another direction is that quantity severed might cause price. We cannot ignore this possibility because quantity severed plays a vital role in determining price. Another possibility is that a feedback loop exists between price and quantity severed. If this is the case, we need to develop a simultaneous equation model to describe the relationship. Another possibility might be that price and quantity severed act independently. Since this is a strictly empirical test for causality, the Granger's test used in this study is based on ordinary least squares estimation as proposed by Geweke (1982).

Let S_t be the quantity of pine sawtimber severed in period t and P_t be its price. n and m are the number of lags used for quantity severed and their prices respectively. Then P does not cause S if and only if the (minimum mean square error) linear predictor of S_t based on $S_{t-1}, \dots, S_{t-i}, P_{t-1}, \dots, P_{t-j}$, is identical to the linear predictor based on $S_{t-1} \dots S_{t-n}$ alone. That means knowledge of past prices of pine sawtimber does not help to predict the quantity severed. Given

$$S_t = b_{10} + \sum_{i=1}^n b_{1i} S_{t-i} + u_{1t}$$

(9)

$$S_t = b_{20} + \sum_{i=1}^n b_{2i} S_{t-i} + \sum_{j=1}^m c_{2j} P_{t-j} + u_{2t}$$

(10)

$$P_t = c_{30} + \sum_{j=1}^m c_{3j} P_{t-j} + u_{3t}$$

(11)

$$P_t = c_{40} + \sum_{j=1}^m c_{4j} P_{t-j} + \sum_{i=1}^n b_{4i} S_{t-i} + u_{4t}$$

(12)

where u_{1t} , u_{2t} , u_{3t} , and u_{4t} are the error terms for equations (9) to (12) respectively and are assumed to be white noise with zero mean and constant variance, in equation (10) $c_{2j} = 0$ for $j=1$ to m means past prices do not cause current period quantity severed. Similarly, in equation (12) $b_{4i} = 0$ for $i=1$ to n means quantities severed in the past do not cause the current period price. The expected sign of c_{2j} is positive because higher past prices stimulate larger harvests. The actual sign of the coefficient is empirically determined. Similarly, the expected sign of b_{4i} is negative, because with higher supplies in the past current prices are expected to decline. Again, the sign of the coefficient is also empirically determined. If both c_{2j} and b_{4i} are insignificant, we can say that price and quantity are working independently. Conversely, if both c_{2j} and b_{4i} are significant then we

can say there is a feedback loop between price and quantity severed. If a feed backloop exists, simultaneous equations will be required to model the timber market (in the present context this would be beyond the scope of this work).

The test of the hypothesis that P_{t-j} does not cause S_{2t} is a test that $c_{2j}=0$ for $j= 1, 2, 3, \dots, m$. The test statistic is an F-test obtained by estimating equation (10) as the unconstrained model and equation (9) as the constrained model and conducting an F-test as follows:

$$F = \frac{(SSE_c - SSE_u)/m}{SSE_u/(T-k)} \quad (13)$$

where SSE_c and SSE_u are constrained and unconstrained sum of squares of errors, respectively. m is the number of constraints imposed for the number of lags for the prices. T is total number of sample observations; k is the number of parameters in the unconstrained model. If the calculated F-value is greater than the 5% critical value with $m, T-k$, degrees of freedom, then the null hypothesis is rejected. That means past prices cause the current period quantity severed (equations 9 and 10). Similarly past severances cause the current price (equations 11 and 12).

Data sources and description

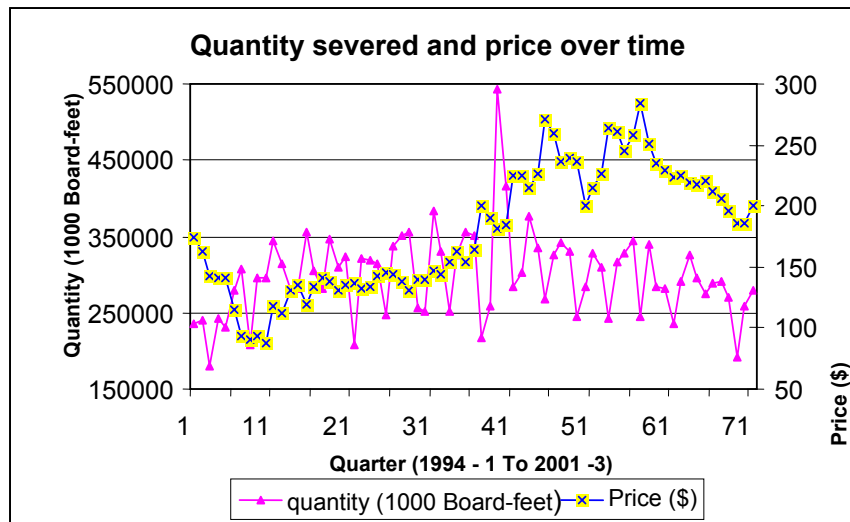
Price and quantity severed data for pine sawtimber were obtained from the Office of Forestry, Louisiana Department of Agriculture and Forestry. Quantity severed of pine sawtimber was available monthly, whereas price data were reported quarterly. Although high, low, and average prices were available quarterly, average prices were selected for this study. Monthly severance data were compiled into quarterly data expressed in 1000 board feet to match with price data. The nominal stumpage prices were converted into real prices by dividing the nominal price with CPI for all United States urban consumers, with the base period 1982-1984 =100. The sample data were available from the first quarter of 1984 to the third quarter of 2001 for 71 quarterly observations.

Descriptive analysis

The mean quantity severed per quarter was 298.184 million board-feet, with a maximum severance of 543.316 million board-feet and a minimum of 180,570 thousand board-feet. Overall quantity severed over time was more or less constant.

Table 1. Variability of quantity severed and price of pine sawtimber

Variable	Observations	Mean	Std Dev	Minimum	Maximum
Price (\$)	71	178.8	50.85	87.16	283.87
Quantity of Severance (1000 board-feet)	71	298,184	55,873	180,570	543,316



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The mean price per thousand board-feet for the 71 quarters was \$178.80 with a minimum of \$87.16 and a maximum of \$283.87. The coefficient of variation for quantity severed was higher (28.73%) than that for price (18.73%). Data also show that there was low correlation between price and quantity severed as evidenced by the very low correlation coefficient 0.014.

Model estimation and hypothesis testing

Choosing the length of lag represents a common problem in time series analysis. Because of the immediate availability of existing timber stands, it is assumed that if there is any response of price to quantity severed or vice versa, it should occur within two years. However for better results, lag lengths were further scrutinized by using AIC criteria. For the quantity model, explanatory variables S_{t-4} , S_{t-6} , S_{t-8} , P_{t-1} and P_{t-4} yielded the minimum AIC values. Similarly, for the price model explanatory variables P_{t-1} , P_{t-4} , P_{t-8} , S_{t-2} , S_{t-5} and S_{t-6} gave the minimum AIC values. We did not eliminate insignificant lag variables that preceded significant ones. All lag variables up to the point of the last significant lag variable were included because their inclusions do not affect the outcome of our estimations. Results of these models are as follows:

1. **Quantity model:** Based on equation (10), the null hypothesis was that there is no relationship between current quantity severed and past prices. The estimated model is as given below:

$$S_t = 258903 + 0.04314 S_{t-1} - 0.09354 S_{t-2} - 0.12977 S_{t-3} + 0.22765 S_{t-4} \\ (2.88) \quad (0.32) \quad (-0.74) \quad (-0.95) \quad (1.67) \\ + 0.07767 S_{t-5} - 0.14506 S_{t-6} + 0.0018 S_{t-7} + 0.25924 S_{t-8} \\ (0.57) \quad (-1.12) \quad (0.01) \quad (1.98) \\ + 648.1 P_{t-1} + 140.6 P_{t-2} - 599.7 P_{t-3} - 347 P_{t-4} \\ (1.36) \quad (0.22) \quad (-0.95) \quad (-0.74) \\ (14)$$

Adj. R square= 0.3654 MSE= 1818621980 DF= 50 F= 3.97
p=0.0003

In equation (14), S_t is the current period quantity of pine sawtimber severed in thousand board-feet. Numbers in parentheses are t-ratios of the estimated coefficients. The model was significant, which is evident from the p-value of the F test. Lag quantities and lag prices explained only about 37 percent of variation in the current quantity S_t of pine sawtimber severance between the first quarter of 1984 and the third quarter of 2001. The impact of past quantities on current quantity varied considerably, as evidenced by the positive coefficients of S_{t-1} , S_{t-4} , S_{t-5} , S_{t-7} and S_{t-8} and the negative coefficients of S_{t-2} , S_{t-3} and S_{t-6} . Furthermore, comparatively higher t-ratios for S_{t-4} and S_{t-8} indicate that quantity severed follows a seasonal pattern.

Joint impact of past prices was tested by using an F-test. SSEs were obtained from constrained and unconstrained models to calculate the F value.

$$F = \frac{(SSE_c - SSE_u)/m}{SSE_u/(T-k)} = \frac{(1.077669 \cdot 10^{11} - 90931099024)/4}{90931099024/(63-13)} = 9.072$$

where the number of constraints m is 4 and the number of total parameters k in the unconstrained model is 13. The calculated $F = 9.072$ is higher than the 5% significant F value of 2.557 with 4 and 50 degrees of freedom. We reject the null hypothesis of no influence of past prices ($C_1 = C_2 = C_3 = C_4 = 0$) on the current quantity severed. Although each individual coefficient was insignificant, they were significant jointly. We conclude that past prices cause the quantity severed.

2. **Price model:** in this model the current price is the dependent variable and past quantities and past prices are the independent variables. Lag length was identified by using AIC criteria where minimum value was obtained from lag prices up to P_{t-8} and lag quantities up to S_{t-6} . The estimated model is presented below;

$$\begin{aligned} P_t = & -94.18 + 0.79027 P_{t-1} + 0.02256 P_{t-2} + 0.03393 P_{t-3} - 0.0931 P_{t-4} - 0.14375 P_{t-5} \\ & (-2.81) \quad (5.81) \quad (0.13) \quad (0.20) \quad (-0.55) \quad (-0.87) \\ & + 0.1935 P_{t-6} - 0.1867 P_{t-7} + 0.3226 P_{t-8} + 0.000033 S_{t-1} + 0.000101 S_{t-2} \\ & (1.17) \quad (-1.14) \quad (2.58) \quad (0.87) \quad (2.66) \\ & + 0.00003 S_{t-3} + 0.0000036 S_{t-4} + 0.000113 S_{t-5} + 0.000075 S_{t-6}. \\ & (15) \\ & (0.69) \quad (0.08) \quad (2.71) \quad (1.95) \\ \text{Adj. R-square} = & 0.94 \quad \text{MSE} = 144.7 \quad \text{DF} = 48 \quad F = 73.27 \end{aligned}$$

In equation (15), P_t is the current price of pine sawtimber in dollars per thousand board-feet. The numbers in parentheses are t-ratios of the coefficients. The overall model was highly significant. It is interesting to note that past quantities severed and past prices explained about 94 percent of the variation in current price. Coefficients P_{t-1} and P_{t-8} were positive and highly significant. This is evidence that price also shows patterns of seasonality.

Similarly, past quantities positively contributed to price changes and it is evident from the sign of coefficients for the past quantities S_{t-1} , S_{t-2} , S_{t-3} , S_{t-4} , S_{t-5} and S_{t-6} . Among these coefficients, S_{t-2} and S_{t-5} were highly significant.

For the causality test, the null hypothesis in this model was that coefficients of past quantities ($\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$) equal zero. This joint test was conducted by an F-test with constrained and unconstrained models.

$$F = \frac{(SSE_c - SSE_u)/J}{SSE_u/(T-k)} = \frac{(10833 - 6945.4)/6}{6945.4/(63-15)} = 6.58$$

The calculated $F = 6.58$ is larger than the 5% significant F value of 2.294 with 6 and 48 degrees of freedom; hence, we rejected the null hypothesis and concluded that past quantities of harvest cause the current price of pine sawtimber in Louisiana. The inclusion of past quantity data increased adjusted R^2 from 0.92 to 0.94.

These OLS estimates for the price model were slightly affected by the usual statistical problems of multi-collinearity, as evidenced by the high R^2 value (0.955) and the few significant variables. Since our purpose in this study was to test joint effect of past quantities on the current price we did not correct for it in our OLS models. Similarly, we also tested for the presence of conditional heteroscedasticity for both models using four lag periods. In both cases p -values of F -ratios were more than 0.40, which was much larger than the critical value of 0.05. This suggests that in both cases the error terms were homoscedastic. An autocorrelation test was conducted by using Durbin's h -test because we were using lagged dependent variables as independent variables. In both models, p -values of Durbin's h -ratios were larger than 0.49, which was much larger than the critical value 0.05. Therefore, both OLS models performed well considering autocorrelation.

Ramsey's (1969) RESET specification test was used for both of these models, mainly because of its simplicity of implementation. An F -test was conducted for both models by using the original unconstrained model as the constrained model for the RESET test and the original unconstrained model plus the squares, cubes, and quadruples of the predicted values of the dependent variable as the explanatory variables in the new unconstrained model. Results are given below:

Quantity model:

$$F = \frac{(SSE_c - SSE_u)/m}{SSE_u/(T-k)} = \frac{(90931099024 - 81374770642)/3}{81374770642/(63-16)} = 1.800$$

The calculated F -value 1.800 was less than the critical value 2.80 at $\alpha=0.05$ with 3 and 47 degrees of freedom, indicating that these three variables were insignificant to the model. We concluded that there was no misspecification of this model.

Price model:

$$F = \frac{(SSE_c - SSE_u)/J}{SSE_u/(T-k)} = \frac{(6945.43 - 6443.13)/3}{6443.13/(63-18)} = 1.195$$

The estimated F -value of 1.195 was less than the critical F -value 2.80 at $\alpha=0.05$ with 3 and 45 degrees of freedom. This joint test showed that inclusion of polynomial terms of predicted prices did not contribute to the model. Therefore, there was no misspecification for the price model.

SUMMARY AND CONCLUSION

Granger's causality test is a strictly empirical test to determine the causal relationship between price obtained and quantity of pine sawtimber severed by private industrial and non-industrial forest landowners in Louisiana. Based on Granger's definition, quantity severed causes price if we are better able to predict price with the quantity data than without them in our analysis. Similarly, price causes quantity if the price information helps predict the quantity severed.

The OLS procedure specifically developed by Geweke for this purpose was carried out against both data sets from the first quarter of 1984 to the third quarter of 2001. Results of the statistical analyses indicate that prediction of future price and future quantity is improved if we consider price and quantity data rather than price alone or quantity alone. In other words, we find strong evidence that past quantities helped predict the current price and past prices helped predict the current quantity. As such the results suggest that a simultaneous equation relationship exists between stumpage prices and timber severed. It is also interesting to note that the price model is substantially better explained than the quantity model in our analyses.

The result of this study also suggests that timber price is very efficient. Simple past prices and past quantity alone are very good predictors of current price. In this case, the immediate past can tell a lot about current situation, a result that is quite compatible with the timber market where many buyers and many sellers interact. No individual buyer or seller is capable of making "big" money from an information monopoly. Timber suppliers are getting competitive prices and timber buyers are paying competitive prices. This empirical test thus lends support to the hypothesis that a competitive timber market exists. It is also found from this empirical test that a price signal lasts at least two years for the pine sawtimber market. Another very exciting result is that the price from two years prior is a significant predictor of current price.

Weak prediction of quantity severed is attributed to many other factors such as seasonality involved in harvesting, forward contracting between sellers and buyers, and sizable volumes of inventory stock for longer periods. The effect of seasonality is observed very strongly in quantity severed, which is expected in the timber market, since timber harvesting depends on weather. The result of this study is quite consistent with what is observed in actual conditions, where changes in quantity cannot be explained by just past prices and volumes.

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Southern Softwood Trends from a Timber Mart-South Perspective

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Abstract: An overview of Timber Mart-South, the quarterly market report for timber products in the Southeastern U.S., includes a short history of the pricing service, market areas we serve, and reporting methods. An update features price changes since our last presentation at SOFEW in 2002. A major product market review analyzes the markets for southern pine stumpage. We use highlights from the Timber Mart-South Market Newsletter with reports on changes in mill production, changes in industry structure, significant weather events, and other timber market news.

Key Words: Timber Mart-South, stumpage, prices, southern pine, markets

INTRODUCTION

Timber Mart-South, a quarterly market price survey and report of timber products in the Southeastern U.S., was founded by Frank Norris in 1976 and then acquired by the Frank W. Norris Foundation in October of 1995. Under the Foundation's ownership, the Report is published, according to contract, at the D.B. Warnell School of Forest Resources at the University of Georgia.

Timber prices are published quarterly for twenty-two Southern U.S. market areas along with state-level averages and a south-wide price index. We quote average-low, average-high, and over-all average prices on pine and hardwood sawtimber, pine and hardwood pulpwood, pine plylogs, poles, and chip-n-saw as well as pine and hardwood chips. Prices are listed in U.S. dollars per thousand board feet (Scribner, Doyle, and International log rules), per cord, and per ton. Each complete regional report contains eleven four-page state reports listing stumpage and delivered prices. All reports are designed to give the facts you need in a simple, easy-to-read format.

Timber price information is obtained from a variety of buyers, sellers, and brokers located throughout the Southeast. A survey is made of a large number of mills, yards, contractors, investors, and consultants engaged in the timber business on a day-to-day basis. Actual timber sales are used for much of the database. Reported prices are then sorted, averaged, and published at the end of each quarter.

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High-average prices represent the average of the upper fifty percent of the quarter's reported prices. Obvious outlier prices are discarded before this calculation. Low-average prices represent the average of the lower fifty percent of prices. Over-all average prices represent the average of these two averages.

Prices provided by Timber Mart-South are unbiased, independent, and offer a ready source of timber market information. Timber Mart-South is an invaluable tool for both buyers and sellers as a guide to the market value of timber products in an area. Our historical price series provide an excellent view of the trends in prices throughout the South.

Timber Mart-South Services

Since the relocation of Timber Mart-South to the University of Georgia, efforts to produce a reliable and useful publication have expanded the base of price reporters from 133 to more than 200. This was the result of a concerted effort to increase the scope and distribution of price reports.

Another on-going project is the publication of a timber market newsletter, the *Timber Mart-South Market Newsletter*. Listing mill openings/closures/curtailments, company restructuring, mill/land acquisitions, and any other information that may affect the price of timber currently or in the future, the newsletter has become a comprehensive source for Southeastern U.S. timber market information. Our regular quarterly press releases keep national and worldwide media aware of timber prices.

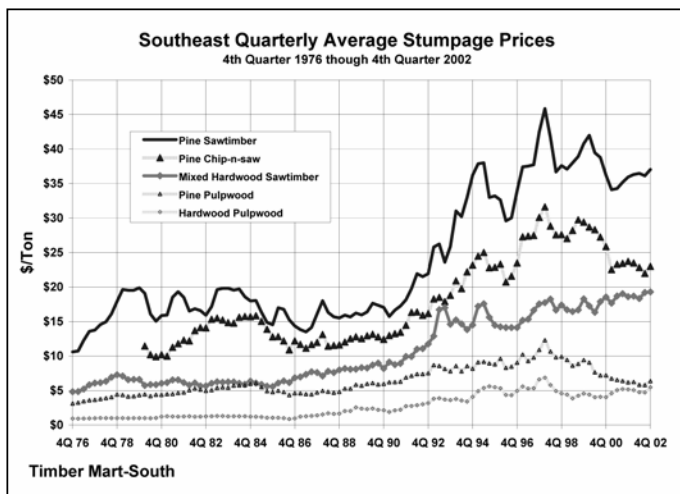
To supplement our archive of twenty-six years of timber price reports, computerized historical timber price data has allowed trend analysis to become an additional service offered by Timber Mart-South. Our website, www.TimberMart-South.com, provides public access to our archive of newsletters and press releases, as well as charts showing the quarterly stumpage prices for major timber products. In 2001, we started email delivery of our reports in machine-readable format. These added services have increased the number of subscribers to Timber Mart-South by fifty-four percent. We also fill many orders for individual reports and contract for special projects.

There are two constant goals for Timber Mart-South. The first is to provide continuity in the reports. This allows the database to be an effective tool for following trends in timber product prices. Secondly, we continually evaluate the need for improvement in the quality of the report, including accuracy of published prices as well as enhanced report presentation and readability.

Ideas for future development include providing custom area reports that aggregate several normal reporting regions or a group of selected counties; increasing awareness of our instructor packets to aid in teaching about timber markets; and providing prices for other, species-specific products in active markets when available. TMS also plans to increase online delivery to include the download of reports and data from our website.

Southern Timber Market Trends

Timber Mart-South brings our subscribers analysis of the current news and events in the Forest Products Industry. For example, the year 2002 brought the end to a prolonged drought in the Southeastern U.S. Heavy precipitation reduced logging in wet areas, putting upward pressure on hardwood prices. A southern pine bark beetle epidemic in the eastern South meant salvaged beetle-killed pine put downward pressure on pine prices in many timber markets from northern Alabama east to South Carolina. An overview of timber prices shows that the record-breaking stumpage rates enjoyed in 1996 through 1998 have declined. In Figure 1, pine and hardwood sawtimber stumpage rates recovered from lows of 1st Quarter 2001 with increases in four out of five major products



in 2002.

Figure 1: Southeast Quarterly Average Stumpage Prices: 4th Q 1976 to 1st Q 2003

Only pine chip-n-saw prices remained lower than the 4th Quarter 2001 by the end of 2002. Over a ten-year period, pine pulpwood prices had a declining trend, reflecting a reportedly widespread over-supply. Some analysts expressed concern that the over-supply in pine pulpwood would eventually spread to smaller sawtimber.

Policy issues related to timber markets included the International Trade Commission's ruling that placed high duties on Canadian lumber imports. In addition, press reports on arsenic in treated wood provoked an industry shift to wood preservatives without arsenic.

Weakening in the "strong dollar", which some had blamed for reduced exports of U.S. wood products, was just one of the economic changes in the U.S. business markets as the country came to grips with the economic recession of 2001. Equity markets reached five-year lows in 2002. GDP growth for the year totaled 2.4 percent, up from 0.3 percent of the previous year, and housing starts continued to make a substantial contribution to GDP growth, reaching new record highs fueled by record low mortgage interest rates.

As in any business, the dynamics of supply and demand drive forest products markets. Dividing the markets into pulp-consumption and solid wood-consumption, we found different demand trends between the two sectors in 2002.

Pulp Demand Changes

International pulp prices were at ten-year lows in 2002. U.S. pulp production decreased from 2001 to 2002 but less than one percent. Paper production dropped about 2 percent while paperboard production increased almost 3 percent according to the American Forest & Paper Association (AF&PA.) Figure 2 shows wood pulp production levels and how southwide average pine pulpwood stumpage prices declined but at a slower rate in 2002 than over the previous four years. Pulp capacity in the South has declined from peak levels of 1995 through 1998 and industry restructuring appears to have responded to changes in global fiber markets.

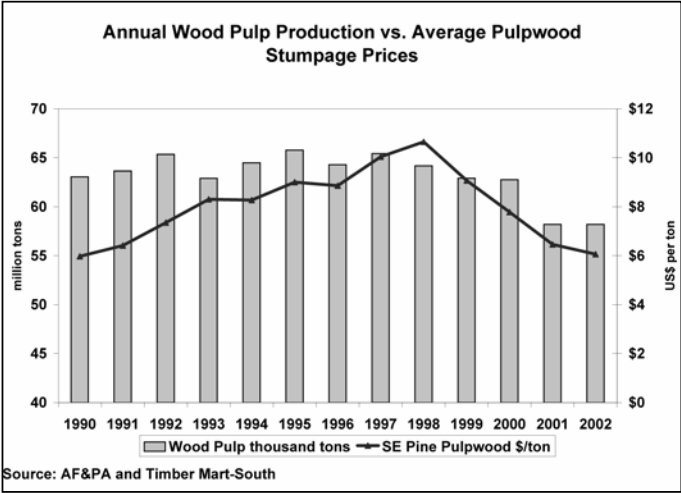


Figure 2: Annual Wood Pulp Production vs. Average Pine Pulpwood Stumpage

Softwood Lumber Demand Issues

The Canadian softwood lumber import controversy has highlighted both the U.S. trade imbalance and the impact of international exchange rates. In the U.S., softwood lumber imports have increased from about 18 billion board feet in 1996 to about 21.5 billion board feet in 2002. Southern yellow pine (SYP) production nearly reached peak levels of 2000 in 2002 (Figure 3.) Pine sawtimber stumpage prices appear to have responded favorably, but some analysts suggest that the prices were weaker than could be expected from such high production levels.

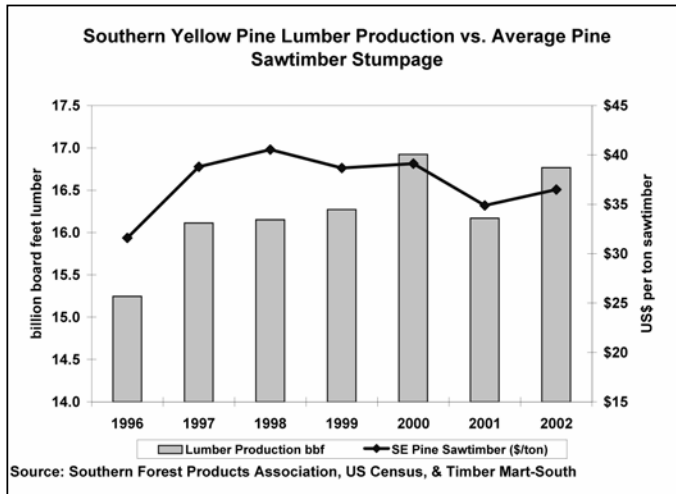


Figure 3: Southern Yellow Pine Production vs. Average Pine Sawtimber Stumpage

Record low lumber prices maintained downward pressure on pine sawtimber stumpage prices in 2002. High levels of production by Canadian lumber manufacturers and sawmills in the South reportedly over-supplied lumber markets. Mill curtailments, in spite of record-level production, suggest an excess of sawmill capacity in the South.

Softwood lumber markets have continued to be impacted by the voluntary decision of the lumber treating industry to move consumer use of treated lumber products away from a variety of pressure-treated wood that contains arsenic such as chromated copper arsenate (CCA). An emotion-laden campaign, waged primarily in the U.S. press, provoked the latter defensive move by the industry. Between one-third and one-half of SYP lumber production receives further processing by pressure-treatment. These industry changes take full effect by the end of 2003. The impact on stumpage markets will depend upon whether the end users continue to choose wood over its competitors: steel, plastic and concrete.

Foreign Trade

The Federal Reserve Board exchange rate data show that foreign currency of both U.S. forest products competitors and markets have "strengthened" against the Dollar over the past seven years. The U.S. competes with Canada, Europe, Australia, and New Zealand for wood markets such as Japan. As a result of the relative exchange rates, from 4th Quarter 1997 to 4th Quarter 2002, pine sawtimber stumpage prices in the U.S. South

increased at about 1.7 percent annual rate, but the same pine sawtimber would have increased at an annual rate of 4.0 percent in Canadian Dollars, 5.4 percent in Swedish Krona or 6.1 percent in Australian Dollars. In the Japanese market, pine sawtimber prices would have risen 5.8 percent in Yen per ton. As a consequence of the strong dollar, the U.S. Forest Products Industry lost considerable cost advantage over its international competitors.

The easing of this long-term trend in late 2002 meant that as pine sawtimber stumpage prices in the U.S. South increased from 4th Quarter 2001 to 4th Quarter 2002 in U.S. Dollars, they also increased but to a lesser extent in Japanese Yen per ton and Canadian Dollars. Prices actually dropped in Swedish Krona, Australian Dollars, and New Zealand Dollars as the U.S. Dollar “weakened” against those currencies. The strong dollar had opened the door to increased foreign lumber imports into the U.S. and at the same time shut the door to exports of lumber and other wood products from the U.S. South. Time will tell whether a weakening Dollar can slow or reverse the trend and how long such a change might take.

Mill Curtailments

A review of Timber Mart-South market news shows that in 2002, the Forest Products Industry continued a pattern of consolidation through mergers and purchases. In general, the publicly traded companies have purchased other companies and sold timberland. Changes included divestment of timberland by the publicly owned corporations: 1.1 million acres in the U.S. South in 2001, 1.2 million in 2002. Between the 1st Quarter 2001 and 4th Quarter 2002, Timber Mart-South reported that thirty-four pulp mills in the U.S. South curtailed production and two closed permanently as a result of the decrease in pulp and paper demand. We also reported that ninety-six softwood sawmills in the U.S. South curtailed production and twelve closed permanently. Panel production, a third market for timber, also curtailed production: fifty-nine mills out of sixty-eight. Five plywood mills closed with one re-opening in 2002. On a more positive note, two OSB mills opened in 2001 and in 2002 manufacturers announced expansion planned for the future.

In spite of the economic climate, the southern timber markets strengthened towards the end of 2002 and average stumpage prices gradually increased. At Timber Mart-South, we attribute such resilience to the South’s unique characteristics as a timber-growing region. Private ownership, high timber growth rates, easily harvested terrain and excellent infrastructure can continue to keep southern markets competitive in an increasingly global timber market.

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Potential Applications for Weather Derivatives in Managing Fiber Supply Risk

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Price volatility, unplanned mill downtime, timber harvest regulations and surprise log truck inspections can lead to disruptions of expected wood flows. Fortunately, most of these disruptions can be mitigated through inventory management and good communication. However, catastrophic or severe weather events can exceed the management abilities and operational flexibility of the most talented wood supply organization. Recent weather-related woodfiber shortages at major Southern pulp and paper mills highlight this risk. We explore the potential of “insuring” against bad weather using exchange-traded, temperature-related weather derivatives. Specifically, we ask “how might weather contracts help minimize financial exposure for wood supply managers in the forest products industry?”

Weather risk is “volumetric” risk, representing the potential impacts on earnings and cash flow from changes in volume. Weather protection takes two primary forms: insurance and derivatives. Insurance policies exist for catastrophic weather events or “business interruption.” Alternately, financial derivatives hedge, or protect from, certain types of weather risk. Derivatives, financial tools that include options and futures, are contracts that get their value from underlying assets such as stocks or oil or mortgages. These contracts enable buyers to lock in prices for future sales or purchases.

Weather derivatives, available since the mid 1990’s, typically payoff based on changes in temperature, snowfall or precipitation. Initially, these contracts traded over-the-counter (OTC). Since 1999, however, weather contracts have been available on the Chicago Mercantile Exchange (CME).

Users of weather derivatives include farmers, energy firms, ski resorts and theme parks. Any firm that can establish a clear connection – a strong and significant correlation – between weather changes and revenue may find weather derivatives useful.

In the forest products industry, potential applications for weather derivatives include tree planting, logging and log hauling, wood procurement and log inventories. Already, some building contractors use weather derivatives for projects with sensitive deadlines.

Weather derivatives have limitations. First, exchange-traded weather contracts are available in only ten U.S. cities, which make their use limited for typically urban forestry activities. Second, weather derivatives continue to face pricing issues. Third, measuring the need and performance of weather derivatives for day-to-day users remains challenging.

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Complexities of Hardwood Roundwood Supply and Demand

William Luppold and Matthew Bumgardner¹

Abstract: While roundwood (sawlogs, pulpwood, etc.) can be treated as intermediate products in the production process that converts stumpage to primary forest products, hardwood roundwood often is traded in identifiable markets. Markets for hardwood roundwood exist because of variations in the value of this material within and among hardwood stands due to differences in species mix and bole quality. Further, individual trees can be processed or merchandized into numerous products with each product going to a different primary processor. Because the merchandizing process has an underlying profit motive, the characteristics of hardwood roundwood markets in a given area influence what sites will be harvested and what trees will be removed. In this paper, we examine the industries that use hardwood roundwood, characterize the attributes of the material used, and describe different methods by which roundwood is distributed. There are three broad categories of hardwood roundwood markets: esthetic, industrial, and fiber. While roundwood used to manufacture products for esthetic application may account for only a small portion of total roundwood harvested, the value of these products has a distortional influence on what sites will be disturbed. Also, because of the skewed value of hardwood material, the potential value distribution of a given stand may be determined largely by a small percentage of trees in that stand.

Key Words: Hardwood, markets, roundwood

INTRODUCTION

Roundwood products have traditionally been classified in generic groupings such as pulpwood, sawlogs, and veneer logs (USDA For. Serv. 1958, 1965, 1982) and assumed as intermediate steps in the production process. While such terminology and assumptions are convenient for accounting purposes and applicable to most of the softwood consuming industries, they may imply an oversimplification of hardwood markets. Hardwood trees tend to grow in mixed-species stands, numerous types of hardwood roundwood can result from a single stand, and resulting hardwood roundwood can be actively traded in a multitude of markets. Understanding markets and their characteristics are important when evaluating their impact on forest ecosystems because they determine what sites will be harvested and what trees will be removed.

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The objectives of this paper are to examine: hardwood roundwood supply, characteristics of roundwood consumption by major hardwood industries, and variations in the price of roundwood and related stumpage. We also provide examples of how local variations in timber resources and changing markets can influence roundwood demand. It is hoped that the information presented here will benefit individuals attempting to understand hardwood markets and/or predict future hardwood resource use on a regional or subregional basis.

Hardwood Stumpage and Roundwood Supply

Most hardwood timber is privately held with more than 70% controlled by nonindustrial private owners (Smith et al. 2001). This ownership may allow hardwood stumpage and roundwood supplies to be more market driven than supplies of softwood that are greatly influenced by decisions made by corporations and government owners of timber (both U.S. and Canadian). The distribution of species, quality, and esthetically important growth characteristics (ring count, color, consistency of ring count, roundness of bole, etc.) varies within and among regions.

Hardwood roundwood can be obtained from growing stock or nongrowing stock portions of the timber resource. Growing stock can be divided into sawtimber size material (over 11.0 inches dbh) and poletimber. Nongrowing stock is comprised of saplings, cull trees, and cull sections of trees, tops, limbs, and roots. Trees classified as cull have poor form, presence of rot, or short bole length. Quality roundwood can be obtained from trees with short butt logs and some nongrowing stock sections such as crotch and burl can be processed into valuable lumber and veneer.

Table 1 presents estimates of roundwood removals by major product and roundwood category (USDA For. Serv. 2002). This information was developed using timber product output studies conducted in 1996 or prior years and may not totally reflect current consumption. Greater use of satellite pulp chipping operations and development of new technology in engineer product manufacturing may have increased the proportion of nongrowing stock used.

Table 1. Hardwood roundwood consumption by product and source

Resource	Sawtimber	Veneer	Pulp	Composites
Total volume consumed (mil. cu. ft.)	1,902.0	145.9	2,189.4	242.6
Proportion of sawtimber (%)	87.2	94.7	49.0	53.2
Proportion of poletimber (%)	3.4	0.3	37.5	38.4
Proportion of nongrowing stock (%)	9.4	5.0	13.5	8.4

¹ Estimates based on timber product output studies and inventory removal estimated during or prior to calendar year 1996.

The Current Hardwood Market

The hardwood industry is a diverse collection of processors that use hardwood roundwood of differing quality and value. Historically, hardwood materials have been most valued for esthetic or “appearance applications, thus fashion considerations have a significant influence on the use and value of species. Hardwood roundwood also can be used for the production of industrial products such as pallets or for the production of paper and engineered wood products

Table 2. Primary hardwood industries, principal products manufactured, value range of roundwood purchased, and potential volume of roundwood requirements that could be supplied by nongrowing stock trees

Industry	Category of roundwood products consumed	Timber output category listed in Table 1	Quality category of wood commonly consumed	Value range of roundwood primarily	Potential use of nongrowing stock resource
Face veneer mills (slicer)	Esthetic	Veneer	Veneer logs	High to very high	Slight
Face veneer mills (rotary)	Esthetic	Veneer	Veneer or sawlogs	Medium to high	Slight
Large sawmill (grade mill)	Esthetic or industrial	Sawlog	Sawlogs	Medium to high	Low
Large sawmill (industrial)	Industrial or esthetic	Sawlog	Sawlogs and bolts	Low to medium	Medium
Medium Sawmill	Esthetic or industrial	Sawlog	Sawlogs and bolts	Low to high	Low to medium
Plywood mill	Esthetic or industrial	Veneer	Sawlogs and bolts	Low to medium	Low to medium
Pulpmill	Fiber	Pulp	Cull logs, bolts, tree-length logs, chips, mill residue	Very low to low	Medium to high
Engineered products mills	Fiber	Composite	Cull logs, bolts, tree-length logs, roundwood residue	Very low to low	Low to high

Face veneer is sliced or peeled from logs to be used in appearance applications such as paneling and furniture. In general, sliced face veneer is produced from the highest quality logs of fashionable species while manufacturers of peeled face veneer

may use lower quality logs or logs of less valuable species. The face veneer industry is heavily influenced by international demands for logs and veneer (Luppold 1994). On a volume basis, the face veneer industry is small but the relatively small volume masks the impact that this market can have in areas containing high-quality timber.

Eastern hardwood sawmills range in production size from less than 100,000 to more than 40 million board feet (bf) per year (Luppold 1995). These mills used approximately 1.9 billion cubic feet of timber in 1996 (Table 1). Most large mills (yearly production greater than 5 million bf) use higher grade logs and are termed “grade mills” because their principal product is lumber for appearance applications.

Intermediate mills (annual production volume of 2 to 4.9 million bf) tend to process lower grade logs but may be designated as grade mills in northern regions (Luppold et al. 2000). Small sawmills (less than 100,000 to 2 million bf per year) tend to be circle mills or portable band mills and normally use low-value logs or logs of less desirable species to produce industrial products and/or ungraded lumber.

Hardwood plywood manufacturers peel logs on large lathes and use this material to produce interior stock for standard-size panels or flooring blanks, containers or container materials, and specialty products. In general, hardwood plywood is manufactured using lower density species such as yellow-poplar and sweetgum, but specialty manufacturers may use other species, including maple and oak.

Hardwood pulp has traditionally been used to manufacture sheet paper, tissue paper, or packaging materials. Hardwood pulpwood consumption has increased over the last 30 years and in 1996 nearly 2.2 billion cubic feet of hardwood roundwood was consumed as pulpwood (Table 1). Nearly all species of hardwood can be pulped, but denser hardwood species usually are preferred.

Engineered wood products are materials formed by press gluing thin sections of wood that have been formed by flaking or veneering. They are made from low density hardwoods (yellow-poplar, aspen, etc.) and southern pine. The newer OSB mills can use crooked roundwood and limbs, though laminated veneer lumber and parallel laminated lumber require logs that are fairly uniform and straight.

Relative Valuation of Hardwood Roundwood and Stumpage

As the discussion of primary processors suggests, hardwood roundwood markets are numerous due to the different combinations of species and products. Likewise, there can be a considerable range in the price of hardwood products due to variations in quality and fashion trends. By contrast, there are fewer commercial softwood species and fewer markets for softwood products. One way to demonstrate differences between hardwood and softwood products and prices is the Maine stumpage report (Maine For. Serv. 2002) as it provides detailed information for a state with diverse timber-consuming industries (Table 3).

Table 3. Value of hardwood and softwood roundwood products in Maine by value range, state average for 2001

Value range (dollars/MBF) ¹	Softwood products	Hardwood products
Less than 20	Red and white pine pulpwood	Aspen and mixed hardwood pulpwood
21 to 50	Hemlock, mixed softwood and spruce/ fir pulpwood; cedar boltwood	Aspen sawlogs
51 to 100	Hemlock, cedar, and red pine sawlogs	Beech and red maple sawlogs; Aspen, red maple, ash, and yellow birch boltwood; Aspen veneer log
101 to 150	Spruce/fir and white pine sawlogs	White birch, ash, yellow birch sawlogs; Sugar maple, white birch, and red oak boltwood; Red maple veneer logs
151 to 200		White oak and sugar maple sawlogs
201 to 300		Red oak sawlogs and ash veneer logs
301 to 400		Yellow and white birch veneer logs
401 to 550		White oak, red oak, and sugar maple veneer logs

¹ Developed from Maine For. Serv. (2002). International ¼-inch log scale, assuming 2 cords of pulpwood roughly equivalent to 1,000 bf.

Table 3 reveals that the overall range in hardwood stumpage price is considerably wider than that for softwood prices, and that hardwood sawlogs and veneer products have a considerable price range depending on species. In Maine, prices of softwood pulpwood stumpage range upward to \$50 per thousand board feet (MBF) while prices of softwood sawlog stumpage prices range from \$51 to \$150 per MBF. Hardwood pulpwood prices are in a narrow range, but hardwood sawlog prices range from less than \$50/MBF for aspen to more than \$200/MBF for red oak. Veneer log prices range from less than

\$100/MBF for aspen to more than \$500/MBF for sugar maple. The price of hardwood boltwood (short logs that are merchandised primarily in New England markets) ranges from less than \$50/MBF for mixed hardwood to less than \$150/MBF for red oak, sugar maple, and white birch.

The range in hardwood sawlog and veneer log prices in Table 3 relates not so much to the inherent quality of these logs but to their use as described in the previous section. Aspen sawlogs and veneer logs are used primarily by engineered wood products industries. Aspen lumber is the lowest valued northern species (Hardwood Mar. Rep. 2002). In Maine, most red maple veneer logs are consumed by industries that peel rather than slice (plywood and rotary cut face veneer). By contrast, red oak sawlogs tend to be processed into lumber and red oak veneer logs are either sliced or rotary cut for face veneer.

Another aspect of hardwood product prices is that there seems to be no long-term interrelationship between the price of different hardwood species or species groups. For the most part, the price of higher value hardwood products does not seem to be cointegrated over time (Luppold et al. 2001). The lack of cointegration suggests no structured pattern of species substitution.

Examples of Localized Changes in Roundwood Demand

It is sometimes assumed that changes in the production of primary hardwood products are uniform across the eastern hardwood regions. However, we assert that the hardwood resource and demand for this resource varies by location. We support our point by examining changes in regional and subregional hardwood lumber production from 1965 to 2000, and demonstrate how growth in the markets for lower value hardwood roundwood also has varied by region.

In developing new estimates of eastern hardwood production (Luppold and Dempsey 1989) it was found that hardwood lumber production had not changed uniformly among regions between 1965 and 1986. While production increased by 25% and 35% in the northeastern and north-central regions, respectively, production decreased in the south central region and remained constant in the southeast. Luppold and Dempsey attributed these changes in production to changes in international and domestic demand and emphasis on pine production in the south, though a contributing factor to these changes could be the greater increase in sawtimber volumes in the north versus the south during this period (Smith et al. 2001).

A second study by Luppold and Dempsey (1994) examined nine hardwood regions identified in terms of states proximate to one another with similar species composition. In this study, the Central States (Ohio, Indiana, Illinois, Missouri, and Iowa), the Lake States, and a region that included Kentucky and Tennessee had the largest increase in production of lumber while regions to the south and east of these states had smaller or negative increases in production. Again, these findings were linked to changes in the domestic flooring and cabinet industry and to international demand for white oak, both of which affected price and production in the Central States and Kentucky/Tennessee.

An example of how prices for specific groups of species can influence roundwood demand in a given state is sawlog production in Maine. The 21-percent decline in

hardwood production in Maine¹ from 1979 to 1989 (versus the 32-percent increase in national production during the same period) and the subsequent rebound in lumber production apparently hinge on the markets for red oak versus hard maple and other northern hardwoods that are abundant in this state. The 1980's were the age of red oak as oak dominated furniture fashions (Frye 1996) and the price of No. 1 Common oak was second only to that of black walnut and black cherry. Maple prices declined through much of this period and were about 60% of the value of red oak by the end of 1987 (Luppold et al. 2001). By the end of 2000, the price of No. 1 Common color select hard maple was nearly 50% higher than that for similar grades of red oak. This helped boost Maine's sawlog production by 77% from 1987 to 2000.

The data from Maine also point out how a structural shift in production technology can influence demand for a specific roundwood product. Aspen has been a relatively low-value hardwood species that generally has been consumed as pulpwood. In the 1980's, OSB plants were built in Maine resulting in a 20-fold increase in aspen sawlog (as opposed to pulpwood) production from the late 1970s to the late 1980s (P. Lammert, 2002, pers. commun.).

SUMMARY AND CONCLUSIONS

Although roundwood can be considered as an intermediate step between harvesting and primary processing, hardwood roundwood can be traded actively in relatively complex markets. As the relative value of different hardwood roundwood products has become more divergent, there has been added incentive to separate product by quality, species, diameter, color, or other characteristics.

The three broad categories of hardwood roundwood markets -- esthetic, industrial, and fiber -- can include materials that emanate from the growing stock or nongrowing stock portion of forests. Pulpmills and hardwood sawmills consume the greatest volume of hardwood roundwood, but veneer mills, plywood mills, and engineered wood product plants can be important consumers in a specific subregion. However, most consumers of hardwood roundwood other than pulpmills are difficult to define in finite groups.

There are numerous hardwood roundwood markets due to different combinations of species and products, and a considerable range in the price of hardwood products. The ranges in the price of hardwood roundwood products are greatest within the sawlog and veneer log portion of the market due to the relative value of different species and the impact of growth characteristics (ring count, color, consistency of ring count, roundness of bole, etc.) in different markets. Another aspect of hardwood product prices is that there seems to be no long-term interrelationship between the price of different hardwood species or species groups.

¹ Hardwood lumber production was estimated by subtracting the aspen component for what was used primarily to manufacture OSB from total sawtimber production.

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The Effects of Mississippi's Transportation Network on Forest Management and Production Forestry

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Abstract: The transportation system and overall infrastructure of a state is an important element in sustaining economic activity. In Mississippi, the forest products industry accounts for a significant portion of the economy. Every year, more than \$1.3 billion dollars worth of timber is harvested in Mississippi. Without an efficient transportation network, the cost to procure raw material to these mills would be extremely high and the margin of profit low. There are many factors that control a logger's transportation costs, which account for about 40% of total operating costs. The purpose of this study is to examine the transportation of logs in three counties of Mississippi (Alcorn, Oktibbeha, and Wayne) and determine whether different regulations and roads affect wood hauling costs, therefore reducing the quantity of utilized wood by diminishing forest management opportunities. Comparisons with adjacent states will be conducted. This study utilizes a residual value approach for assessing policy impacts on hauling costs. Preliminary results may be presented.

Econometric Analysis of United States Paper Supply: 1981-2001¹

Roger Brown² and Daowei Zhang³

Abstract: Econometric models of U.S. newsprint paper (NP), printing/writing paper (PRP), tissue paper (TP), and packaging paper (PP) supply are presented and evaluated. In each case, supply is modeled using two-stage least squares, monthly data, and a log-linear specification. Sample periods vary from 10 years for TP (1983-1993) to 20 years for NP and PRP (1981-2001). Estimated output price elasticities (and significance levels) are 1.94 (1%) for NP, 1.83 (1%) for PRP, 0.55 (1%) for TP, and 0.15 (34%) for PP. Input elasticities for capital, labor, fiber, wastepaper, and electricity are also reported.

Key Words: input demand, output supply, newsprint, and elasticity.

INTRODUCTION

Under the assumptions of perfect competition, output quantity is a function of output price and input costs. This basic supply relationship is, importantly, a derived result, obtained indirectly by approaching profit maximization as either an unconstrained problem using a variable cost equation or as a constrained problem using the implicit production function (Beattie and Taylor 1993 p205). As a consequence, econometric estimation of supply relationships is usually done one of two ways: directly (by regressing output price and input costs against output quantity) or indirectly (by either minimizing a cost function or maximizing a profit function subject to a given production technology).

Numerous existing studies have estimated output supply and input demand for various pulp and paper product categories using an indirect method. For example, elasticities of input demand were obtained by Boungiorno and Gilles (1980) from international data, and by Boungiorno et al. (1983) from monthly U.S. data, in both cases with generalized Cobb-Douglas cost functions. More flexible forms, such as the translog form, were used by Stier (1980, 1985), DeBorger and Boungiorno (1985), and Quicke et al. (1990) with U.S. data. In Canada, Sherif (1983), Martinello (1985), and Nautiyal and Singh (1986) also used translog cost functions, while Muller (1979), Bernstein (1989), Hseu and Boungiorno (1997) used profit functions to obtain estimates of input demand and output supply.

However, no known study has estimated U.S. paper supply directly. This observation is surprising since direct estimation usually requires less restrictive assumptions. The present paper estimates supply relationships directly for four paper product categories: newsprint (NP), printing/writing paper (PWP), tissue paper (TP), and packaging paper (PP). Each model is independent of the others with no consideration of input substitution or multiproduct outputs. The remainder of the present paper reviews

¹ Helpful comments on earlier drafts were received from Henry Thompson, Greg Traxler, John Jackson, and Peter Ince.

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the production costs of all four paper grades and proposes empirical models for each that best account for the specific input requirements of each paper type. Results from the four models are presented and evaluated.

Input Factors, Cost Shares, and Market Structure

While each paper grade requires an adjustment to the usual mix of inputs, modern paper production across all paper types is fairly uniform (Table 1). Certain specialty papers designed for niche markets (e.g. hand-made craft paper) have very different production techniques and input requirements than the four paper types examined in this analysis. Capital certainly is the single largest long-run input cost. Paper production generally depends on large, capital-intensive facilities, and the pulp and paper industry consequently ranks near the top of all industries in terms of capital investment per employee (Tillman 1985). When compared to all U.S. manufacturing, the high capital intensity of paper production requires that most firms operate at relatively high operating rates in order to earn revenues beyond this largest cost (Sinclair 1992 p181). Capacity utilization, in fact, is sometimes used as a proxy for capital cost (Quicke et al. 1990). Paper mill capacity utilization rates in the U.S. have ranged between 87% and 95% over the period 1986 to 2000 and have tended to fluctuate with business cycles (NAFB 2002 p19).

Wood is usually the second leading input cost and the primary raw material needed for paper production. Fiber needs tend to vary with paper grades and substitution among different fiber types is for some grades significant (Ince et al. 2001). The primary material input for NP is softwood pulpwood. PWP is a heterogeneous product group that includes coated and uncoated groundwood papers and coated and uncoated free sheet paper. While NP and the groundwood paper grades depend heavily on softwood fiber, free sheet paper grades are made primarily with hardwood pulp or a mix of hardwood and softwood pulps. Uncoated free sheet comprises the

Table 1. Paper production cost shares.

Factor	Share, %
Capital	27
Wood fiber	15
Labor	14
Energy	13
Wastepaper	8
Chemicals	7
Maintenance Materials	6
Operating Materials	4
Packaging Materials	2
Other	4
Total	100

Note: Based on a 450,000 tons/year NP mill with two modern paper machines operating at full production (adapted from Gullichsen and Paulapuro 1998).

dominant share of capacity within the PWP group, accounting for more than half of all capacity throughout 1970 to 2000 (Ince et al. 2001). Also, the largest number of U.S. uncoated free sheet mills are located in the North and are based primarily on the purchase of market pulp. TP and PP have the most variable fiber requirements. Fiber furnish for TP ranges, for example, from 100% virgin fiber (usually a blend of softwood and hardwood chemical pulps for primary grades) to 100% recycled fiber (for lower quality grades). Packaging papers include a broad range of products (e.g. grocery bags, multiwall shipping sacks, and industrial wrapping papers) and are likewise noted for their diverse fiber sources (NAFB 2002 p235). The principle fibers for PP are woodchips, sawdust, virgin softwood pulp, and recycled paper.

Labor, energy, and recycled paper are typically among the other most significant factor inputs. Union membership among production employees is strong with labor agreements typically negotiated for 5 to 6 year periods (NAFB 2002 p70). Pulp, paper, and paperboard mills account for about 12% of total manufacturing energy use in the U.S., ranking it second only to chemical production in terms of energy intensity. On average, over half of total fuel and electricity use by all paper mills (56% in 1993) was self-generated primarily from spent pulping liquors, wood residues, and bark. However, PWP production (specifically uncoated free sheet production based on chemical pulp) accounts for the majority of this self-generated energy. Recycled paper—also called recovered or waste paper—is an increasingly significant input factor for environmental, legal and marketing reasons though input cost shares are still typically low. Recycled paper provides nearly 37% of all the fiber furnish used at U.S. paper mills, up from 25% in 1988 (NAFB 2002 p173). Paperboard mills (not examined in here), however, are the dominant demander of recycled paper and, among the paper grades examined in this analysis, NP and TP are most dependent on this fiber source.

Free competition and pricing based on market forces best characterize the modern U.S. paper industry. The market share of the top 5 North American producers for each paper grade ranges from 60% for PWP to 80% for TP (Roberts 2001). Also, given that average U.S. tariffs on paper have been historically near zero, any effort by large U.S. suppliers to stabilize domestic market prices in the face of a less concentrated global industry is unrealistic (Gullichsen and Paulapuro 1998).

Theoretical and Empirical Models

For a competitive firm facing competitive factor markets, the supply function is found by taking the first derivative of the profit function (Beattie and Taylor 1993 p164). The supply function reveals directly the dependence of output quantity on market price and a set of input costs. If all firms are assumed to operate as a single firm (as assumed here), industry-wide data may be used to develop elasticity relationships.

The general form of the supply function used in this study was:

$$Q = f(P, P_K, P_F, P_L, P_E, P_W)$$

where:

Q = output quantity
P = market price
 $P_K, P_F, P_L, P_E,$ and P_W = prices of capital, fiber, labor, and wastepaper, respectively.

Empirical models for each paper type were developed based on known input cost factors and available data. All four models include grade-specific measures of output quantity and market price. All models include the same measures for capital, labor, and energy. The NP, PWP, and PP models use, respectively, softwood pulpwood, woodpulp (i.e. market pulp), and soft/hardwood pulpwood input cost estimates. The most appropriate choice of fiber for TP would have been a hardwood-only pulpwood but all available data series were either too short or unusable; softwood pulpwood (the same used for NP) was used instead. All four empirical models were expressed in log-linear form and include monthly dummy variables.

DATA

Monthly time series price indices from the Bureau of Labor and Statistics (BLS) were used for all market price and factor cost variables except capital. The labor variable was constructed by deflating the BLS reported average wage of paper mill production workers (dollars/hour) by the BLS consumer price index for urban wage earners and clerical workers. For energy, the price index for industrial electricity was used and for wastepaper (in the NP model only) the price index for recycled newspaper wastepaper was used. The average yield on three-month U.S. treasury bills in secondary markets was used as the opportunity cost of capital. Data on the quantity of paper produced was gathered from each month's hardcopy edition of *Pulp and Paper* magazine from the section titled "Month in Statistics." Time series for each model varied based on the available data: NP (1981 to 2001), PWP (1980 to 2001), TP (1983-1993), and PP (1981-1998).

RESULTS

Regression results for each model are presented in Table 2. As expected, initial OLS estimates revealed that market price and output quantity are jointly determined. Two-stage least square models for each paper type were used to correct for simultaneity bias following Greene (2000 p680). Demand shift variables for use as instrumental variables in first-stage regressions were needed for each paper type. The price of newspapers was the obvious choice for the NP model. North American NP demand is primarily determined by the U.S. daily newspapers, which consume 60% of production (NAFB 2002 p185). Generally, per capita consumption of paper is a measure of living standards; consequently, GDP per capita correlates well with paper consumption, both on a long-term and cyclical basis (NAFB 2002 p14). Quarterly U.S. GDP

Table 2. United States' output price and input demand elasticity estimates for various paper types.

Table 2. United States' output price and input demand elasticity estimates for various paper types.									
Paper type	Constant	Price	Capital	Fiber			Labor	Energy	Waste paper
				Softwood pulpwood	Wood-pulp	Pulp-wood			
..... (elasticities)									
NP	5.739*** (0.977)	1.938*** (0.258)	-0.333*** (0.0152)	-0.860*** (0.154)	--	--	-1.344*** (0.210)	-1.424*** (0.384)	-0.062*** (0.010)
PWP	3.749*** (0.731)	1.833*** (0.198)	-0.163*** (0.028)	--	-0.450*** (0.095)	--	0.041 (0.153)	-0.572*** (0.171)	--
TP	2.69*** (0.974)	0.554*** (0.081)	-0.060* (0.032)	0.492** (0.250)	--	--	-0.859*** (0.300)	-0.678*** (0.263)	--
PP	10.87*** (0.746)	0.146 (0.154)	-0.071*** (0.026)	--	--	-0.301** (0.153)	-0.285 (0.273)	-1.00*** (0.270)	--

Notes: Coefficient estimate different from zero at: * 90% conf. level, ** 95% conf. level, and *** 99% conf. level.

NP = newsprint; PWP = printing/writing paper; TP = tissue paper; and PP = packaging paper.

Standard errors given in parentheses under coefficient estimates.

figures were scaled to obtain monthly estimates. The BLS price index for plastic materials and resin was used as an additional demand shift variable in the PP model since markets for unbleached kraft paper (used to make paper bags) have suffered from significant substitution by plastic bags (Ince 2001 p20). The second stage residuals for each model except TP were highly correlated and Newey-West corrections for autocorrelation were performed following Green 2000 (p464).

OBSERVATIONS AND CONCLUSIONS

All price elasticities of supply are correctly signed and, save PP, are statistically significant. Production capacity in the PP industry, unlike that of other paper types, has been generally declining for the past 20 years due to substitution primarily by plastic packaging materials (Ince 2001 p20). Production at times when market prices are periodically below total costs is sometimes common in declining industries and may help explain PP's apparent insensitivity to changes in market prices and insignificance of the own-price elasticity variable.

Softwood pulpwood in the TP model is incorrectly signed, which was not unexpected since the most appropriate data series—hardwood-only pulpwood—was unavailable. It is not clear, however, why the softwood pulpwood variable is significant. The TP industry is characterized by relatively high operating rates and high industry concentration. These factors suggest that this industry is motivated by interests other than profit maximization (e.g. price stability) and that as a result input cost responses are less predictable. The energy variable in each model is correctly signed and statistically significant. PWP reveals the least sensitivity to changes in industrial electricity prices, most likely a consequence of this industry's relatively high rate of energy self-sufficiency from power cogeneration.

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Error Correction Models and Directed Graphs of U.S. Newsprint Demand

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Abstract: In the past few years electronic and print media appear to be competing for advertising revenue, and trends in electronic media and newspaper advertising expenditures are thought to be major factors affecting newsprint demand. This study presents an analysis of demand for newsprint in the United States. We explore the dynamic relationships among newsprint consumption, newsprint price, gross domestic product (GDP), advertising expenditures in electronic media, and advertising expenditures in newspapers. We employ the methods of error correction models with cointegration and vector autoregression along with directed graphs and variance decomposition to analyze behavior and identify the causal structures of U.S. newsprint demand. The empirical results show that advertising expenditures in both electronic media and newspapers have significant effects on U.S. newsprint demand and consumption in the long run. Advertising expenditures in newspapers are the most important factor determining newsprint consumption, and are influenced by advertising expenditures in electronic media. Newsprint consumption and advertising expenditures in newspapers appear to determine newsprint price. However, GDP had a much less significant impact on newsprint consumption over the observed data period of 1983 to 2000. Finally, we evaluate alternative projections of U.S. newsprint consumption to 2020.

Key Words: newsprint, demand, advertising expenditures, electronic media, newspapers

INTRODUCTION

There has been a decline in U.S. pulpwood demand of historic proportions (~15%) over the last decade. In addition, real pulpwood prices have dropped since 1997. Although newsprint is not the largest element of U.S. wood fiber demand, it has been declining. The potential for future growth in newsprint demand is an issue in forest economics. Newsprint demand is perceived to have interesting relationships to newspaper advertising and electronic media substitution. In a recent timber assessment study, total U.S. paper and paperboard demand was projected to increase, but newsprint demand was projected to gradually recede under the influence of electronic media substitution (Haynes 2001). According to earlier research, electronic media (television, radio, computers) have not significantly influenced the demand for printing and publishing papers in the United States (Zhang and Buongiorno 1997). However, we would observe that printing and publishing papers are a much broader category than is newsprint and include some products complementary to electronic media such as office computer printer paper and reprographic paper. In contrast, according to Hetemäki and Obersteiner (2001) the gross domestic product (GDP) may no longer have a positive relationship with newsprint consumption, and a structural break in U.S. newsprint consumption occurred in 1987. It is important to note that Zhang and Buongiorno used annual data from 1960 to 1991, whereas Hetemäki and Obersteiner used annual data from 1971 to 2000.

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It can be hypothesized that advertising expenditures play an important role in U.S. newsprint demand—advertising accounts for more than 85% of newspaper revenue; the remaining revenue comes from single copy sale and subscriptions (PPPC 2003). Also, since newspaper advertising serves a very broad spectrum of economic and business activities, it can be hypothesized that newsprint demand follows trends in overall economic activity, as represented by GDP.

The objective of this study is to analyze and model U.S. newsprint demand in relation to newsprint price, economic activity (GDP), advertising expenditures in electronic media, and advertising expenditures in newspapers.

DATA DESCRIPTION

Newsprint consumption (metric tons) is apparent consumption, which is equal to production plus imports minus exports. We obtained newsprint apparent consumption data directly from the Pulp and Paper Products Council (PPPC) in Canada. Newsprint price was derived from the producer price index of U.S. newsprint reported by the U.S. Bureau of Labor Statistics (BLS). The BLS newsprint price index was deflated by the broad producer price index for all commodities (producer price index, PPI), transforming it to a real (inflation-adjusted) newsprint price index. We also transformed monthly data of newsprint consumption and price index to quarterly data.

U.S. real gross domestic product (GDP) is real 1996 U.S. dollars from the Bureau of Economic Analysis. Annual advertising expenditures in electronic media and advertising expenditures in newspapers were obtained from Universal McCann. Advertising expenditures in electronic media include expenditures in television, radio, and the Internet. We applied data interpolation techniques in Eviews software to convert advertising expenditures from annual to quarterly. Quarterly advertising expenditures in newspapers are also available at the Newspaper Association of America (NAA) web site. The movement of calculated quarterly advertising expenditures from Universal McCann is similar to the movement of quarterly advertising expenditures from NAA, with a four quarters moving average. We also transformed quarterly advertising expenditures from NAA to annual data and compared these data with the annual advertising expenditures from Universal McCann. The annual data from both sources were equal from 1983 to 1990 and less than 1% different from 1991 to 2000. Advertising expenditures in newspapers and electronic media were deflated by PPI for all commodities. Newsprint consumption, GDP, advertising expenditures in electronic media, and advertising expenditures in newspapers were all transformed to per capita values using U.S. population data from the Bureau of Census. All the data series used in this study were not seasonally adjusted.

METHOD OF ANALYSIS

Cointegration analysis has been widely used to analyze long-run relationships among variables for agricultural commodities (Goodwin and Schroeder 1991, Bessler and Fuller 2000) and forest products (Jung and Doroodian 1994, Hanninen et al. 1997, Hanninen 1998, Murray and Wear 1998, Jee and Yu 2001). For our study, time series cointegration tests were initially performed to examine the dynamic relationships among newsprint consumption, newsprint price, GDP, advertising expenditures in electronic media, and advertising expenditures in newspapers. If variables in X_t are co-integrated, a vector autoregressive (VAR) model with k lags can be reproduced as a reduced rank

regression. Johansen (1988) and Johansen and Juselius (1990) considered the general autoregressive representation as

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-1} + \varepsilon_t \quad (1)$$

Here, X_t is a (px1) vector of time series data, Γ_k and Π_i are (pxp) matrices of parameters from a vector autoregression of X_t of lag order k , p is number of variables, and ε_t is a residual term. Error correction representation (1) resembles a VAR model in first differences, except for the presence of an error correction term, ΠX_{t-1} , which contains information about the long-run relationships among series. If Π has a rank of r (r is a positive number and less than p), there is cointegration and $\Pi = \alpha\beta'$, where matrices α and β are the adjusting speed of each variable to shock in the long-run equilibrium and the long-run relationships among variables, respectively. Our study investigated whether the coefficient matrix Π contains information about long-run relationships among time series data using the Schwarz criterion and trace test.

Furthermore, to better understand relationships among variables contained in their error terms, we used variance decomposition analysis, for which we need to know the structure of contemporaneous error correlations. We applied the theory of directed graphs to identify the causal structure. The directed graphs approach was used to study causal relationships among variables in several studies reported in the economics literatures (Bessler and Akleman 1998, Akleman et al. 1999, Roh and Bessler 1999, Bessler and Fuller 2000). The directed graph method allows for a data-determined ordering of variables for analysis of variance decomposition. A directed graph is also an assignment of causal flow among variables based on observed correlation and partial correlation. Spirtes et al. (1993) provided an algorithm for removing “edges” (causal flow from one variable to another variable signified by a line segment) and assigning causal relationships among residuals of each variable. The algorithm starts with a complete undirected graph, where residuals from every variable are connected with residuals from every other variable of the system. The algorithm removes edges sequentially between variables based on zero correlation and partial (conditional) correlation. For example, the directed graph $A \rightarrow B \leftarrow C$ represents the linear causal relationship among variables A, B, and C, and this also means that B may be expressed as a function of A and C. In other words, there is a causal connection to B from both A and C. On the other hand, if B causes both A and C, the directed graph will be shown as $A \leftarrow B \rightarrow C$.

EMPIRICAL RESULTS

We selected the lag length at the level VAR before estimating the error correction model (ECM). The lag length determination is an important consideration for the VAR model. The model will be misspecified if the appropriate lag length is not selected. The lag length of 2 was chosen based on the Schwarz criterion. Table 1 shows trace test statistics and Schwarz criteria on the rank of Π , which is equal to the number of co-integrating vectors (r). There is one cointegration relation based on Schwarz criteria, whereas the trace test results suggest three cointegration vectors. In this study, we followed Wang and Bessler (2002) to choose one co-integrating relationship based on Schwarz criteria, as there may be potential problems in interpreting the results for multiple cointegration relations.

Table 1. Tests on order of cointegration

Rank	Trace	Critical value (5%)	Schwarz criterion
R = 0	103.29	75.74	-24.89
R ≤ 1	68.41	53.42	-25.17
R ≤ 2	36.97	34.80	-24.97
R ≤ 3	14.90	19.99	-24.52
R ≤ 4	5.71	9.13	-23.30

Notes: The trace test considers the hypothesis that the rank of $\Pi \leq r$. Critical values are from Hansen and Juselius (table B.2).

Next, we tested for stationarity of each series given one co-integrating vector among five series. Subscripts indicate variables as follows: variable 1 = newsprint consumption, variable 2 = newsprint price, variable 3 = GDP, variable 4 = advertising expenditures in electronic media, and variable 5= advertising expenditures in newspapers. Table 2 provides tests of stationarity for each series. The null hypothesis is that each series is stationary. We rejected the null hypothesis of stationarity for each series.

The ECM was estimated with one cointegration vector. The expected relationship is based on the assumption that advertising expenditures in electronic media have a negative effect on newsprint consumption. For the short run, the parameters of the newsprint consumption equation have correct signs, but the estimated parameters of newsprint price, GDP, advertising expenditures in electronic media, and advertising expenditures in newspapers are not statistically significant. Newsprint consumption responds negatively to newsprint price (-0.68) and advertising expenditures in electronic media (-1.0) and positively to advertising expenditures in newspapers (1.35) and GDP (0.77), as expected, in the long run. Coefficients estimated of short- and long-run newsprint consumption are

$$\begin{aligned} \Delta X_{1t} = & -0.71\Delta X_{1t-1} - 0.07X_{2t-1} + 0.33X_{3t-1} - 0.20X_{4t-1} + 0.71X_{5t-1} \\ & - 0.20(X_{1t-1} + 0.68X_{2t-1} - 0.77X_{3t-1} + 1.0X_{4t-1} - 1.35X_{5t-1} + 3.16) \end{aligned} \quad (2)$$

Table 2. Test for stationarity

Series	LR test	χ^2	Decision
X_1	28.26	9.49	Reject
X_2	11.31	9.49	Reject
X_3	28.13	9.49	Reject
X_4	29.20	9.49	Reject
X_5	26.79	9.49	Reject

Directed graph analysis was used to identify the causal structure using the residuals correlation from the ECM estimation. As the directed graph indicates, causal relations exist among variables (Fig. 1). Advertising expenditures in newspapers and newsprint consumption appear to directly determine newsprint price. Advertising expenditures in electronic media do influence advertising expenditures in newspapers. There are, however, ambiguous relationships between newsprint consumption and GDP, and between GDP and advertising expenditures in electronic media. These imply that the correlations among the variables are not rich enough to identify the causal structure in those data series.

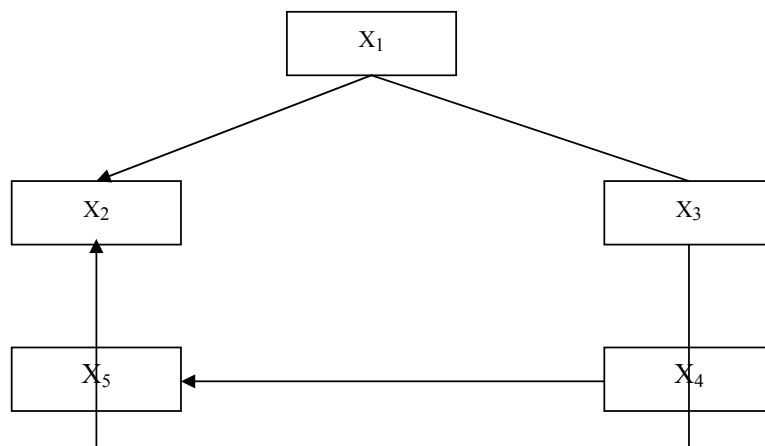


Figure 1. Directed graph for U.S. newsprint demand

Table 3. Decomposition of variance for newsprint consumption

Step	X_1	X_2	X_3	X_4	X_5
	X_1				
1	100.00	0.00	0.00	0.00	0.00
2	91.08	3.03	0.31	2.03	3.55
3	87.48	5.45	0.19	2.76	4.13
24	53.33	12.95	0.52	16.69	16.51

The causal relations of residuals in contemporaneous time, generated by the directed graphs, were used in variance decomposition analysis. The variance decompositions indicate how the variance in the newsprint consumption equation is composed. Variation in newsprint consumption in the short run is mostly explained by its own variation (87% to 100%) (Table 3), and in the long run by variation in newsprint price (13%), advertising expenditures in electronic media (17%), advertising expenditures in newspapers (17%), and its own variation (53%). It is interesting to note that the variation in newsprint consumption is not explained by the variation in economic growth (GDP) at all steps. The structural break may have taken place in U.S. newsprint consumption in 1987 (Hetemäki and Obersteiner 2001).

Figure 2 shows the calculated newsprint consumption based on the estimated ECM equation and compared to observed newsprint data and Figure 3 the newsprint consumption projection based on estimated ECM newsprint consumption equation and trend assumptions for independent variables. Newsprint price was assumed to increase to \$520/short ton by 2004 and stay there to 2020 (when this paper was prepared, the U.S. newsprint list price was relatively low, about \$470/short ton, whereas \$520/short ton would be close to the median price range in recent years). The GDP projection to 2020 was the same as projected in the RPA Assessment. Advertising expenditures were assumed to grow at their average rates of the last 5, 10, and 20 years, respectively, providing a range of alternative projections.

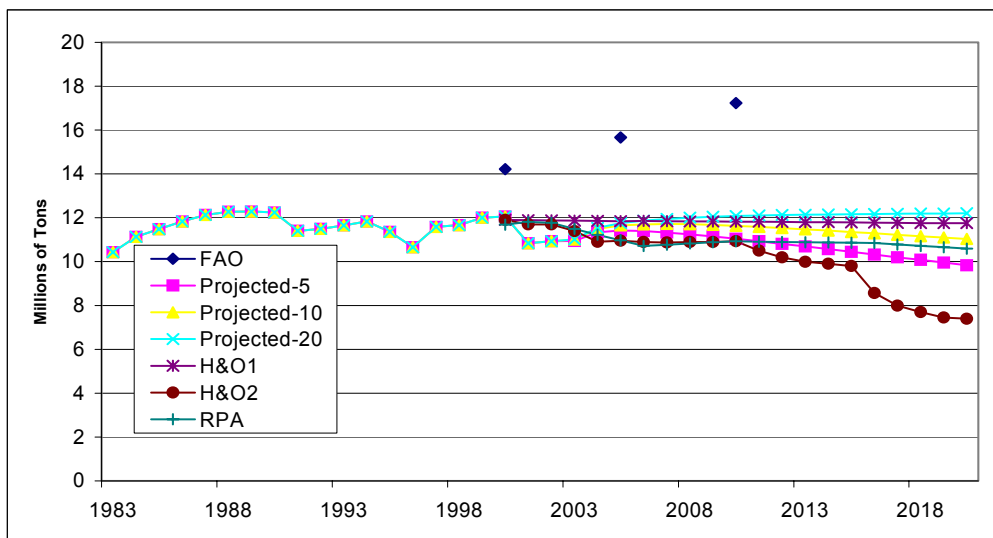


Figure 2. Calculated and observed past values of newsprint consumption.

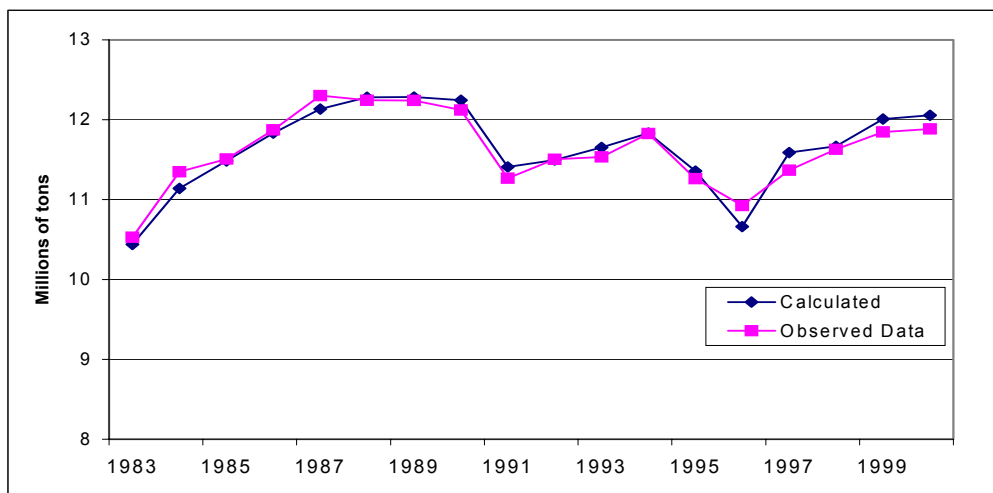


Figure 3. Forecasting of newsprint consumption compared with other studies.

Both the projection obtained from the newspaper circulation model (H&O2) and our projection using the growth rate of the last 5 years (Projected-5) show a declining

outlook from 2003 to 2020. The projection of newsprint consumption decreases to 10 millions tons by 2020 using the average growth rate of the last 5 years (Projected-5) for advertising expenditures, whereas newsprint consumption will be 11 and 12 millions tons by 2020 using the average growth rates of the last 10 or 20 years (Projected-10 and Projected-20, respectively) for advertising expenditures. The newsprint consumption projection of the most recent RPA Assessment (RPA), the projection of Hetemäki and Obersteiner's classical model (H&O1), and our projection using the average growth rate of the last 20 years (Projected-20) remain steady from 2010 to 2020. By contrast, recent FAO projections showed U.S. newspaper consumption rising to more than 17 million tons by 2010 (FAO 1999).

CONCLUSIONS

An error correction model and directed graphs approach were used to examine relationships among advertising expenditures in newspapers and electronic media, economic growth, and U.S. newsprint demand. Advertising expenditures in both electronic media and newspapers play a very important role in newsprint consumption. As expected, newsprint consumption has negative relationships with advertising expenditures in electronic media and newsprint price and positive relationships with advertising expenditures in newspapers and GDP.

Causal relationships among variables were identified. Newsprint price is determined by advertising expenditures in newspapers and newsprint consumption. Advertising expenditures in electronic media affect advertising expenditures in newspapers, supporting the hypothesis of media substitution via shifts in advertising expenditures. However, the relationship among newsprint consumption, GDP, and advertising expenditures in electronic media remains ambiguous. From the analysis of variance decomposition, newsprint price has a smaller role in influencing newsprint consumption than does advertising expenditures in electronic media or newspapers in the long run. The variation in newsprint consumption is not explained by the variation in GDP. Model projections indicate that U.S. newsprint consumption will likely increase only modestly, to 12 million tons, over the next few years assuming that growth in advertising expenditures returns to the average growth rate of the past 20 years. However, the model projects that newsprint consumption will decrease to 10 million tons by 2020 if advertising expenditures grow at the average rate of the last 5 years.

Our findings suggest that advertising in electronic media appears to be substituting for newspaper advertising. An increase in advertising expenditures in electronic media could decrease advertising expenditures in newspapers and result in decreasing newsprint consumption. Furthermore, the growth of newsprint consumption may no longer be explained well by the growth in economic activity (GDP). Projections indicate that U.S. newsprint demand may have reached a plateau in total tonnage and may gradually decline in the future despite anticipated growth in real GDP. However, U.S. newsprint production and advertising expenditures in all media are components of GDP. The variables are not independent of each other. The potential impacts of multi-collinearity should be investigated in future study.

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Land Use Change Determinants by Ownership and Forest Type in Alabama and Georgia

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Abstract: This paper analyzes the determinants of timberland use by ownership and forest type in Alabama and Georgia during 1972-2000. Higher forestry returns help to increase the share of timberland ownership by forest industry and NIPF. Hardwood sawtimber prices and poor land quality appear to increase timberland use towards hardwood forest types at the expense of oak-pine mixed, and softwood types. Increases in population and per-capita income have a negative impact on forestry and agricultural land use as well as timberland use by ownership and forest type.

Key Words: Timber land, land quality, federal incentives, multinomial logit.

INTRODUCTION

This study deals with changes in the timberland by ownership and by forest types. Recently, there have been several attempts to model and project land use along the lines of major uses, i.e., forestry, agriculture, and urban uses (Alig 1986; Hardie and Parks 1997; Ahn, Plantinga, and Alig 2000, 2001; Hardie et al. 2000). Few studies have dealt with the changes in the timberland by ownership and by forest types.¹

Between 1972 and 2000, ownership pattern of timberland has witnessed change (Table 1). In Alabama, while the timberland under public and non-industrial private forest (NIPF) ownership increased by 20 and 11 percent, private forest industry ownership declined by 11 percent. In Georgia, the timberland under public and forest industry ownerships increased respectively by 11 and 13 percent, the NIPF ownership of timberland declined by 9 percent.

Changes have also been taking place in the timberland area under different forest types. There has been a shift towards increasing the timberland under hardwood forest type at the expense of softwood and mixed forest types (Table 1). While the timberland under softwoods increased marginally by 3 percent, there was a decline in the timberland under oak-pine mixed forest type, and a dramatic increase of 25 percent in the timberland under hardwood forest type in Alabama between 1972 and 2000. In Georgia, the timberland under softwood and mixed forest types each declined by nearly 13 percent between 1972 and 1997. During the same period, the timberland under hardwood forest type increased by 12 percent.

The changes in timberland ownership pattern and forest type have implications for recreational activities, biodiversity, and water quality. Changes in forestland could imply a significant impact on the condition of forests and their ability to provide wildlife habitat, recreation, and environmental amenities (Wear 2002). Due to increasing population and economic growth, the U.S. South experienced dramatic growth in urban sprawl. Increasing population and economic growth have also spurred the demand for

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recreation, especially forest-based outdoor recreation, while access to recreational land is increasingly limited to owners themselves (Cordell and Tarrant 2002).

This paper examines changes in the ownership pattern and forest types of timberland using county level data for Alabama and Georgia. The next section briefly reviews previous literature and describes the analytical framework used in this study. The third section describes

Table 1. Changes in timberland use by ownership and forest type in Alabama and Georgia

Particulars	Alabama (1,000 Acres)			Georgia (1,000 Acres)		
	1972	2000	% change	1972	1997	% change
<i>By ownership:</i>	21,333.1	22,926.5	7.5	24,839.0	23,795.3	-4.2
Public	1,020.5	1,230.0	20.5	1,571.5	1,751.2	11.4
Forest industry	4,204.9	3,740.4	-11.0	4,318.2	4,890.7	13.3
NIPF	16,107.7	17,956.1	11.5	18,949.3	17,153.4	-9.5
<i>By forest type:</i>	21,333.1	22,926.5	7.5	24,839.0	23,795.5	-4.2
Softwood	7,863.7	8,089.0	2.9	12,325.2	10,805.3	-12.3
Oak-pine	5,016.9	4,193.7	-16.4	4,142.9	3,613.3	-12.8
Hardwood	8,456.5	10,577.9	25.9	8,370.9	9,376.9	12.0

^a Misc. area includes water area, unproductive forests and productive reserve forests.

data and their sources. The fourth section presents and discusses the results. The final section concludes.

Literature Review and Analytical Framework

Typically forest returns, timber price, timber-to-crop income ratio act positively on increasing the timberland shares (Alig 1986; Ahn, Plantinga, and Alig 2001; 2002). Increases in timber establishment costs and planting costs discourage forestland use. Increasing farm expenditures discourage agricultural use and promote conversion into either urban land or forestland. Personal income, household income and per capita income affect negatively on the timberland and agricultural land use and in favor of urban land use. Increasing inflation favors conversion of land into forestry use (Alig 1986; Hardie and Parks 1997).

Population density is a key variable in converting the forest land and agricultural land to urban use (Alig 1986; Ahn, Plantinga, and Alig 2001; Hardie and Parks 1997; Hardie et al. 2000). As population increased, more land was needed for home sites, roads, airports, school, commercial, and industrial sites, parks, open space, and other uses to satisfy the demands of urbanized areas (Vesterby and Heimlich 1991; Reynolds 2001). The proportions of rural population and urban population have also been shown to be affecting the land use (Alig 1986).

The quality of land has a major influence governing the use of land for agricultural or forestry purposes (Parks and Murray 1994; Hardie and Parks 1997; Plantinga, Mauldin, and Alig 1999; Ahn, Plantinga, and Alig 2001). Higher quality land is naturally put to higher income uses in agriculture and lower quality land to forestry uses. In empirical analyses, the proportion of two higher land quality classes in the total land of a county has been shown to affect whether the land is put to agricultural or forestry use.

Empirical analyses have shown that distance to city has a negative influence on the agricultural and urban land use, while it has positive influence on forest land use under NIPF and forest industry ownership (Ahn, Plantinga, and Alig 2001; 2002). Distance to interstate highways may act positively on the forest land use and negatively on agricultural and urban land uses. Slope of land has also been an influence on how land is used, agricultural land use preferring land with lower slope in comparison with forest land use (Parks and Murray 1994).

Since the start of Agricultural Conservation Program in 1930s, several programs such as Soil Bank Program of 1950's, Forestry Incentives Program (1972), tree planting program of Conservation Reserve Program (1985), and Stewardship Incentives Program (1993) have influenced landowners' behavior in favor of forestry. These programs resulted in increasing forestry land use and decreasing the agricultural land use (Alig 1986) and significantly influenced forest tree planting (Kline, Butler, and Alig 2002).

Following Miller and Plantinga (1999), and Hardie et al. (2000), a model of land use is developed from the viewpoint of landowners' decision problem of allocating a fixed amount of land to alternative uses. Optimal (or expected) land use shares, p_{ikt} (proportion of land in k -th use, in i -th county, at time t), in the total land, are specified as multinomial logistic functions of a linear combination of vector of explanatory variables, X_{it} , and vector of unknown parameters, β_k

$$(1) \quad p_{ikt} = \frac{\exp(\beta_k' X_{it})}{\sum_{k=1}^K \exp(\beta_k' X_{it})}$$

The land uses can be non-industrial timberland, industrial timberland, agricultural land, and urban/other land (i.e., $k = 1, \dots, K-1, K$). The explanatory variables, X_{it} , used in literature often include (a) economic variables: forest returns, agricultural returns, urban rent, and per capita income; (b) demographic variables: population density, urban/rural population ratio, and average age; (c) land quality variables: average land quality and the proportion of two higher quality classes; (d) geographical variables: distance to city, slope and travel time; and (e) policy variables: government forestry cost-share programs and farm assistance programs.

The logistic specification is convenient because it constrains the sum of land use shares to one. If we normalize equation system (1) by one of the land use shares (for example, $k=4$) and by constraining $\beta_4 = 0$, the multinomial logit model becomes

$$(2) \quad p_{ikt} = \frac{\exp(\beta_k' X_{it})}{1 + \sum_{k=1}^{K-1} \exp(\beta_k' X_{it})} \quad \text{for } k = 1, \dots, K-1$$

and the share for the omitted land use is recovered as

$$(3) \quad p_{i4t} = \frac{1}{1 + \sum_{k=1}^{K-1} \exp(\beta_k' X_{it})}.$$

Logarithmic transformation of equation system (2) yields a three equation system

$$(4) \quad \ln\left(\frac{p_{ikt}}{p_{i4t}}\right) = \beta_k' X_{it} \quad \text{for } k = 1, \dots, K-1.$$

Since the optimal land use shares, p_{ikt} , are not observable and may be different from actual land use shares due to random factors, they are replaced with actual (or observed) land use shares, y_{ikt} , and error terms are introduced in the system. The system of equations in (4) then becomes

$$(5) \quad \ln\left(\frac{y_{ikt}}{y_{i4t}}\right) = \beta_k X_{it} + \varepsilon_{ikt} \quad \text{for } k = 1, \dots, K-1$$

The logarithmic transformation and use of both time series and cross sectional data may induce heteroskedasticity problem which is corrected by White's (1980) estimate of covariance matrix.

For ease of interpretation, marginal effects and elasticities are estimated at mean levels of variables. Marginal effects are estimated as per formula given by Greene (1990, p.666), and acreage elasticities are calculated with the help of formula given by Wu and Segerson (1995, p.1037). Marginal effects and acreage elasticities for the multinomial logit function are not monotonic, but depend on the point of evaluation and can vary in sign and magnitude according to the value of x , and the proportions of land use p_{ikt} .

DATA

The variables used and the data sources are listed in Table 2. This analysis used data for 67 Alabama counties for the years 1972, 1982, 1990, and 2000 and 159 Georgia counties for the years 1972, 1982, 1989, and 1997 obtained from Forest Inventory and Analysis (FIA) surveys.

Land in agricultural use includes cropland, pastureland, and rangeland available from agricultural censuses at 5-year intervals. To conform to FIA survey years, these numbers were interpolated for 1972 and 1990 for Alabama and for 1972 and 1989 for Georgia, using annual compound growth rates between the relevant agricultural census years. The area under agricultural land use for the year 2000 for Alabama was obtained by extrapolating from 1997 using annual compound growth rates between 1992 and 1997. The implicit assumption is that the agricultural land use changed at the same compound growth rates between the relevant years.

Land in other category includes urban land, roads and rural transportation and was estimated by subtracting water area, productive and unproductive reserve forest land, timberland, agricultural land from the total land area of counties. Total land and water area were from 2000 population census while productive and unproductive reserve forest land area were from FIA.

Table 2. Description and data sources of variables used in the analysis

Variable	Description	Source
WTDSTPR	Sawtimber price weighted by pine sawtimber and oak sawtimber removals (\$/MBF)	Timber Mart-South
PSTPR	Pine sawtimber price (\$/MBF)	Timber Mart-South
OSTPR	Oak sawtimber price (\$/MBF)	Timber Mart-South
AGVAL	Average value per acre of farm real estate.	NASS
PD	Persons per acre of total land area of county	Census Bureau
INC8284	Average per capita personal income of county in thousand dollars	REIS of BEA
AVLCC	Weighted average land capability class of counties	USDA
LCC1N2	Proportion of highest land quality classes I and II in the total land of the counties	USDA
CSACRES	State average of tree planting acres in thousands for the previous period.	NRCS
PLCOST	Average planting cost in 1992 dollars (1992=100) for US South	Kline; Dubois et al.

To represent the returns to forest land use, a county level weighted sawtimber price (Dollars per MBF) was calculated using Timber Mart-South prices and county level sawtimber removals for softwoods and hardwoods available from FIA as weights. For 1972, pine sawtimber and oak sawtimber prices were obtained by tracing backwards from 1977 using the percentage changes in Louisiana prices (Howard 2001). Three area prices before 1992 were converted to two area prices using conversion weights developed by Prestemon and Pye (2000). The sawtimber prices were deflated using PPI for all commodities (1982=100). Average value per acre of farm real estate from various agricultural censuses is used as proxy for representing the county agricultural returns. Interpolations were used for the years corresponding to FIA years using the method explained above. These values were deflated using Consumer Price Index-Urban (CPI-U), 1982-84=100.

Population density was estimated as number of persons per acre of total land area of county using Census Bureau's mid-year estimates from Regional Economic Information System (REIS) of Bureau of Economic Analysis (BEA). County level per capita personal income numbers were obtained from REIS. These numbers were deflated using CPI-U.

Two land quality variables were used in the analysis. The U.S.D.A. classifies land into 8 land capability classes (LCC) in the decreasing order of land quality (Klingebiel and Montgomery 1961). The ratings for a land parcel range from 1 to 8 where 1 is the most productive land and 8 is the least productive land. The average land quality index (average LCC) was calculated as a weighted average of acres in each land class in the county. The second variable is the proportion of LCC 1 and 2 in the total land area. The values of the two land quality variables were different for counties, but same for all the analysis years.

For acreage under cost share programs, a state level variable for annual average number of acres of trees planted under various cost share programs was constructed using the cost share acres for the previous 7 to 10 years for each FIA survey.² These numbers

change over years but same for every county in each particular year since state level numbers were used. Cost share acres for tree planting for period 1962-85 were obtained from USDA Forest Service (1986) and for subsequent years from serial publication *Agricultural Statistics*, Farm Service Agency and Natural Resource Conservation Service. The data on tree planting cost is the index in 1992 dollars (1992=100) for the U.S. South obtained from Kline (Per. Comm.).

RESULTS AND DISCUSSION

The analysis is accomplished at two levels. First, forest ownership is studied. The total area of land in this category is the sum of timberland owned by private forest industry, NIPF landowners, agricultural land, and urban/other land, and excludes all types of public land. Second, three forest type groups are examined. Softwood forest type includes longleaf-slash pine, loblolly-shortleaf forest species groups. Mixed forest type is comprised of oak-pine forest type group. Hardwood forest type includes oak-hickory, oak-gum-cypress, elm-ash-cottonwood, and non-stocked forest species groups. The total land area in this category is the sum of land under softwood, mixed, hardwood forest types, agricultural land and urban/other land.

Ownership

The explanatory powers of the estimated equations according to ownership type are between 0.26 and 0.43 (Table 3). The effect of timber price is positive and significant on the share of both forest industry and NIPF ownership. Agricultural land values have a significantly negative impact on the shares of forest industry ownership, but not a significant effect on the share of non-industrial forestry ownership. Agricultural land values have no influence on the share of agriculture as indicated by its insignificant coefficient.

As expected, population density has significant negative impact on the shares of forest industry and NIPF land ownerships as well as agricultural land use. The per capita personal income has the expected negative influence on the shares of all types of ownerships but the effect is not significant for the share of agricultural land use.

The LCC1N2 has significant negative impact on the shares of both private and non-industrial forestry ownerships, while it has significant positive impact on the share of agricultural land use. The AVLCC has the expected negative impact on the agricultural land use share, but the coefficients for both the forestry ownerships are negative, contrary to our expectations. Acreage under cost share programs has insignificant impact on the shares of both private forest industry and non-industrial private forest ownership.

Elasticity estimates indicate that the sawtimber prices and cost share acres have positive effect, while agricultural land values, planting costs, per capita personal income and proportion of higher land quality classes have negative effect on forest industry timberland ownership. For NIPF timberland ownership, personal income and LCC1N2 have negative effect and declining AVLCC has positive effect. For agriculture land use, declining AVLCC and increasing sawtimber prices are negative factors and increasing proportion of LCC1N2 is a positive factor.

Forest types

The explanatory powers of the four estimated equations in this category range from 0.32 to 0.52 (Table 4). In the softwood and mixed forest type equations, except for AVLCC and planting cost, all coefficients are significant and have the expected signs. In the hardwood forest type equation, the pine and oak sawtimber prices have the expected reverse impact on the share of hardwood forest type. The effect of agricultural land value is negative and significant on the share of hardwood forest type. The coefficients for population density and per capita income are significant and have expected negative impact on the share of hardwood forests. The cost shared acres is not a significant variable in affecting the share of hardwood forests.

In the agricultural land use equation all coefficients are significant and as expected, except for oak sawtimber price. Pine sawtimber price exerted a significant negative influence on the share of agriculture land use. Among the remaining variables, agricultural land values, LCC1N2, and planting cost had positive influence on the share of agriculture land use, while population density, per capita personal income, and AVLCC had significant negative effect.

Table 3. Land use determinants by ownership, Alabama and Georgia, (K=4; obs.=833)

Variable	Coefficient	Standard Error	Marginal Effects	Elasticities
<i>(a) Industry owned timberland use, Dep. variable: Ln(Ind/Urban&Other), Adj. R² = 0.42</i>				
Constant	3.6541***	0.8524		
WTDSTPR	0.0034***	0.0007	0.0002	0.3308
AGVAL	-0.0013***	0.0002	-0.0001	-1.0549
PD	-0.0018***	0.0004	-0.0001	-0.0650
INC8284	-0.1475***	0.0373	-0.0077	-0.7212
AVLCC	-0.2262*	0.1163	-0.0034	-0.1373
LCC1N2	-2.9064***	0.5449	-0.2145	-0.6043
CSACRES	0.0035	0.0027	0.0004	0.1769
PLCOST	-0.0007	0.0038	-0.0006	-0.6734
<i>(b) NIPF owned timberland use, Dep. variable: Ln(NIPF/Urban&Other), Adj. R² = 0.26</i>				
Constant	2.3687***	0.5167		
WTDSTPR	0.0017***	0.0005	0.0003	0.0753
AGVAL	-0.00007	0.0001	0.00005	0.0824
PD	-0.0013***	0.0002	0.00001	0.0026
INC8284	-0.0887***	0.0235	-0.0101	-0.1648
AVLCC	-0.1689**	0.0691	0.0136	0.0946
LCC1N2	-1.1277***	0.3144	-0.2033	-0.0993
CSACRES	-0.0001	0.0016	0.0004	0.0324
PLCOST	0.0075***	0.0024	0.0013	0.2658
<i>(c) Agricultural land use, Dep. variable: Ln(Agri/Urban&Other), Adj. R² = 0.43</i>				
Constant	1.8342***	0.6314		
WTDSTPR	-0.0007	0.0006	0.0001	-0.2922
AGVAL	0.0001	0.0001	0.00002	0.2107
PD	-0.0021***	0.0002	0.0000	-0.0975
INC8284	-0.0272	0.0326	-0.0031	0.4164
AVLCC	-0.4012***	0.0806	0.0042	-0.8457
LCC1N2	0.9594**	0.3340	-0.0621	0.4933
CSACRES	-0.0060***	0.0020	0.0001	-0.2287
PLCOST	0.0050*	0.0028	0.0004	-0.0182

*, **, *** indicate significance levels at 0.10, 0.05, and 0.01 probability.

Estimates of elasticities for forest type indicate that increasing pine sawtimber prices and cost share acres act positively and both the land quality variables act negatively for the shares of softwood forest type. Increasing proportion of higher land quality, personal income, and pine sawtimber prices act negatively, while increasing oak sawtimber prices and decreasing average land quality act positively on the shares of land use under oak-pine mixed forest type. For hardwood forest land use, planting costs, personal income, and pine sawtimber prices exert negative influence, whereas poorer land quality and oak sawtimber prices exert positive influence. Increasing proportion of higher land quality, agricultural land values impact agricultural land use shares positively, while poorer average land quality, pine sawtimber prices and cost share acres impact negatively.

Table 4. Land Use Determinants by Forest Types, Alabama and Georgia, (K=5, obs.=878)

Variable	Coefficient	Standard Error	Marginal Effects	Elasticities
<i>(a) Softwood forest type land use, Dep. variable: Ln(Soft/Urban&Other), Adj. R² = 0.32</i>				
Constant	2.4945***	0.6088		
PSTPR	0.0041***	0.0010	0.0012	0.7146
OSTPR	-0.0019**	0.0009	-0.0011	-0.3759
AGVAL	-0.0003***	0.0001	0.0000	-0.1551
PD	-0.0007***	0.0001	0.0000	0.0101
INC8284	-0.1612***	0.0253	-0.0109	-0.3576
AVLCC	-0.2532***	0.0778	-0.0364	-0.5051
LCC1N2	-2.5040***	0.3936	-0.4819	-0.4660
CSACRES	0.0064***	0.0020	0.0011	0.1651
PLCOST	0.0098***	0.0029	0.0014	0.5648
<i>(b) Mixed forest type land use, Dep. variable: Ln(Mixed/Urban&Other), Adj. R² = 0.35</i>				
Constant	1.1183*	0.5768		
PSTPR	-0.0017*	0.0010	-0.0002	-0.2602
OSTPR	0.0047***	0.0009	0.0003	0.2599
AGVAL	-0.0001	0.0001	0.0000	0.0244
PD	-0.0009***	0.0001	0.0000	-0.0253
INC8284	-0.1523***	0.0270	-0.0031	-0.2724
AVLCC	-0.1339*	0.0751	0.0006	0.0216
LCC1N2	-2.2232***	0.3742	-0.1515	-0.3867
CSACRES	0.0035*	0.0020	0.0001	0.0421
PLCOST	0.0104***	0.0028	0.0006	0.6398
<i>(c) Hardwood forest type land use, Dep. variable: Ln(Hard/Urban&Other), Adj. R² = 0.35</i>				
Constant	1.9418***	0.4931		
PSTPR	-0.0007	0.0008	-0.0002	-0.0925
OSTPR	0.0034***	0.0007	0.0004	0.1332
AGVAL	-0.0001**	0.0001	0.0000	0.0018
PD	-0.0008***	0.0001	0.0000	-0.0029
INC8284	-0.1505***	0.0206	-0.0077	-0.2552
AVLCC	0.0899	0.0649	0.0633	0.8857
LCC1N2	-0.3658	0.3071	0.1413	0.1375
CSACRES	0.0020	0.0016	-0.0002	-0.0230
PLCOST	-0.0007	0.0023	-0.0016	-0.6441
<i>(d) Agricultural land use, Dep. variable: Ln(Agri/Urban&Other), Adj. R² = 0.52</i>				
Constant	2.2131***	0.5839		
PSTPR	-0.0057***	0.0010	-0.0009	-0.9391
OSTPR	0.0064***	0.0010	0.0007	0.4196
AGVAL	0.0000	0.0001	0.0000	0.1429
PD	-0.0013***	0.0001	-0.0001	-0.0973
INC8284	-0.0988***	0.0282	0.0042	0.2429
AVLCC	-0.3953***	0.0729	-0.0445	-1.0815
LCC1N2	1.3775***	0.3016	0.3720	0.6296
CSACRES	-0.0018	0.0019	-0.0007	-0.1849
PLCOST	0.0065**	0.0026	0.0003	0.1840

*, **, *** indicate significance levels at 0.10, 0.05, and 0.01 probability.

CONCLUSIONS

This paper has analyzed the determinants of land use changes using county level data from Alabama and Georgia for the period 1972 to 2000. This analysis is accomplished at two levels: ownership, and forest type. During the period of analysis, timberland area in Alabama increased, while it declined in Georgia. Land in agricultural use declined and land in urban/other uses increased dramatically in both Alabama and Georgia. Industry ownership timberland declined and NIPF ownership of timberland increased in Alabama, while the situation in Georgia was reverse. Among the forest types, area under hardwood forest type increased, while area under oak-pine mixed forest type declined in both the states. Area under softwood forest types slightly increased in Alabama and whereas it showed a decline in Georgia.

Higher forestry returns help to increase the share of timberland ownership by forest industry and NIPF, while higher income levels and higher proportion of good quality land may lead to declines in the share of timberland ownership by forest industry. The NIPF landowners appear to increase their ownership share of lower quality lands, while on the contrary, higher income levels and higher proportion of good quality of land may lead to declining shares of ownership by NIPF landowners.

The trend of increasing hardwood forest type land use, at the expense of oak-pine mixed, and softwood forest types, is driven by increases in population and per-capita income. Increasing softwood sawtimber prices and tree planting under cost share programs have been favorable towards increasing the share of land in softwood forest types. Increasing hardwood sawtimber prices and poorer land quality have promoted increasing the land use shares in hardwood forests.

NOTES:

¹Exceptions are Plantinga and Buongiorno (1990), and Ahn, Abt, and Plantinga (2001).

² For the years 1972 and 1982 annual average of cost shared tree planting acres from 1962 to 1971 and 1972 to 1981 were used respectively for Alabama and Georgia. For the years 1990 and 2000 for Alabama, the annual average of cost share tree planting acres for 1982 to 1989, and 1990 to 1999 were used. For the years 1989 and 1997 for Georgia, the annual average of cost share tree planting acres for 1982 to 1998 and 1990 to 1996 were used.

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Global Status and U.S. Costs of Forest Certification

Thresa Pressley¹, Frederick Cubbage, and Jacek Siry

Abstract: Increased forest certification throughout the world suggests that forest managers and landowners are managing their land in a more sustainable fashion. The cost of certification includes the initial assessment by a certification organization, and the personnel time taken to prepare for and document the management processes. A change in managing forestland as a result of certification will probably incur additional costs for the manager or landowner. This paper will provide an update on the status of forest certification efforts and an analysis of some of the costs associated with forest certification on selected forests in the United States.

KeyWords: environmental stewardship, certification audits, standards, Forest Stewardship Council, Sustainable Forestry Initiative

INTRODUCTION

Forest certification continues to increase globally, providing evidence of environmental stewardship by forest industry and individual forest landowners. World trends in forest certification differ by region with competition among industry and environmental non-government organizations (ENGO) programs.

In theory, there will be an increase in certified wood and the availability of certified wood final products in the future. The process of certifying forests could result in better environmental records and a better perception of the forest industry by the public. These benefits will not be free to the landowner, whether they are forest industry or non-industrial private landowners, due to an increase in costs for managing forests that are certified.

This paper will summarize the current status of forest certification in the world. A survey and analysis of costs associated with the third party inspection and preparation by selected forest owned entities also is included.

FOREST CERTIFICATION STATUS

Certification Extent

Many forests throughout the world are certified by several different certification schemes. Most of the certified lands were certified under one or more of the following certification systems: Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI), Pan European Forest Council (PEFC) and the Canadian Standards Association (CSA). The American Tree Farm System (ATFS), the International Organization for Standardization (ISO) of Canada, and the Keurhout process are not direct forest

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certification systems per se, or not third-party certified yet in the case of ATFS. Table 1 on the following page provides the allocation of certified land by each certification scheme, as of March 2003, based on data from the program web sites.

There are approximately 120 million hectares of forests certified around the world. These certified lands represent 3.1% of the total forests. Europe has 6% and North America has 10.9% of their total area of forests certified with 61.9 million hectares and 51.2 million hectares respectively. Central America and Asia rank next with 1.1% and 0.4% respectively of their total area of forests certified and South America and Africa follow with only 0.3% and 0.2% of total forests certified.

About 95% of all certified forests were in the northern hemisphere, with 41.6 million hectares in the United States, 28.1 in Canada, 21.9 in Finland, 12.4 in Sweden, 9.4 in Norway, 6.7 in Germany, and 6.0 in Poland. Austria had 3.8 million hectares of certified forests, and the Czech Republic, Latvia, Brazil, Estonia, the U.K., South Africa, and Bolivia had between 1.0 and 1.8 million hectares each.

Table 1. Certified Forest Area by Certification Scheme

Certification Scheme	Certified Forest Area
Forest Stewardship Council (FSC)	34.6 mm hectares
Sustainable Forestry Initiative (SFI)	44.0 mm hectares
Pan European Forest Council (PEFC)	46.6 mm hectares
Canadian Standards Association (CSA)	14.4 mm hectares
American Tree Farm System (ATFS)	10.6 mm hectares
ISO – Intl Standards Org (Canada)	11.4 mm hectares
Malaysian Timber Certification Council (MTCC)	1.7 mm hectares
Indonesian Eco-Labeling Institute (LEI)	n.a.
Cerflor – Brazil	0.8 mm hectares
Australia Forestry Standard	n.a.
Keurhout (Trade Org) – Netherlands	32.9 mm hectares

Source: Program web sites, Kiekens, 2003.

Current Developments

We drew on the annual report Forest Certification: 2002 Year in Review (Kiekens, 2003) to provide updates on the preceding data on forest certification.

Forestland certified by the Pan European Forest Certification (PEFC) system increased to 46 million hectares during 2002. The PEFC system includes 13 European forest certification schemes. Efforts are being made for mutual recognition with much of the rest of the tropics and Eastern Europe. The Forest Stewardship Council (FSC) added the Baltic states of Estonia, Lithuania and Latvia to its European certification region. Also some Polish, Croat, Slovak and Russia forests were either certified or undergoing forest assessment in 2002. Other European developments included the revocation of the Ukrainian FSC certificate due to non-payment of certifier's invoice, and the revision of the Dutch Keurhout process for "verifying the acceptability of forest management certificates" (Kiekens, 2003).

In Asia, the Malaysian Timber Certification Council awarded its first forest management certification certificates in 2002 to three Forest Management Units (FMU). The council also awarded certificates for chain-of-custody certification to 16 timber

companies. The first Indonesia Ecolabeling Institute (LEI) Chain of Custody certificate was issued to a wood working company. The chain of custody system had been implemented through a pilot project program and LEI's Interim Accredited Certification Bodies conducted the certification process (Kiekens, 2003).

Brazil and Chile led the efforts for certification in Latin America. The standards for plantation certification for the Brazilian certification system CERFLOR were approved, along with chain of custody and auditing guidelines. In Chile, two certification programs progressed in the development of standards for plantation forestry and native forests. The African Timber Organization (ATO) identified several options for a Pan-African Certification scheme in December. It was recommended that the options be similar to the PEFC framework. In Australia, the Australian Forestry Standard (AFS) was approved. The standard applies to both native and plantation forests, and its certification requirements are based on several recognized certification schemes. A draft FSC plantation standard was developed by New Zealand. The draft was released for public comment and FSC endorsement is being sought even though the developing organization has not been endorsed by FSC (Kiekens, 2003).

U. S. Direct Inspection Costs

Certification audit costs were derived from studies brokered by The Pinchot Institute of Conservation (Mater, 2002) and certification reports from The Southern Center for Sustainable Forests (Cubbage, et al. 2002). Pinchot helped obtain funding for demonstration certification efforts in North Carolina, Maine, Tennessee and Minnesota. State or university lands in North Carolina and Maine received joint FSC and SFI certification. Tennessee and Minnesota have been certified by FSC only. Costs associated with individual certified forests were obtained from state foresters of relevant states (Todd, 2003; Vongroven, 2003; Titus, 2003). Preparation costs were calculated from provided data for preparation time multiplied by labor costs per hour. These costs were then calculated on a per acre basis.

North Carolina

In the State of North Carolina, the Forest Stewardship Council and the Sustainable Forestry Initiative inspected approximately 54,500 acres for the potential certification of forests owned by North Carolina State University (4,500 acres), Duke University (8,000 acres) and the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Forest Resources (42,000 acres). The total inspection costs for FSC were \$78,450, which amounted to about \$1.44/acre. SFI inspection costs incurred for the same acreage, except for 10,000 acres owned by NCDENR DFR, were \$37,325. The allocation of this total cost per acre was \$0.84. The original SFI cost was \$29,668 but NCSU incurred additional cost of \$7,657 for a revisit by the auditors. Excluding the additional cost incurred by NCSU, the cost per acre would have been \$0.67.

Maine

In the Northeast, 480,000 acres of forests maintained by the Maine Bureau of Parks and Lands were assessed by FSC and SFI. The direct inspection costs for the FSC assessment were \$81,595, or \$0.17/acre. SFI direct inspection costs for the same acreage amounted to \$62,725 or \$0.13/acre.

Tennessee

In Tennessee, 158,000 acres were assessed for certification by both FSC and SFI. Direct inspection costs related to the FSC assessment were \$50,000, which equated to \$0.32/acre. The SFI assessment costs \$67,000 or \$0.42 per acre.

Minnesota

Minnesota has 550,000 acres of state administered land located in Aitkin County that were assessed by the FSC. The initial inspection, funded by the Ford Foundation, cost \$30,000. The cost per acre for the initial inspection equated to \$0.05.

U. S. DIRECT PREPARATION HOURS AND COSTS

North Carolina

The entities involved in the North Carolina certification assessment individually tracked the management hours spent in obtaining the certification. Categories representing different stages of the certification process were established for tracking purposes. The categories for which time was divided were: (1) preliminary meetings, (2) pre-audit meetings and preparation, (3) documentation preparation and collection of evidence, (4) office visits by auditors, (5) field visits by auditors, (6) post audit work, and (7) report analysis and response. Total hours for each category were multiplied by an estimated fixed wage of \$50 per hour to determine the total costs associated with preparing for certification. This would cover the salary for a forester, fringe benefits, and fixed overhead costs.

Table 2 represents the direct preparation time spent and costs associated with the certification process for NC State University. For the FSC audit, total preparation costs were \$16,850 or \$3.74/acre. SFI preparation costs were \$43,200, allocating \$9.60 per acre, and the total preparation costs incurred by NCSU for certification were \$60,050 or \$13.34 per acre. Similar calculations were made for Duke University and the North Carolina Division of Forest Resources.

Table 2. North Carolina State University Direct Preparation Hours and Costs

Project Component	Direct Preparation Hours		Direct Preparation Costs (\$)	
	SFI	FSC	SFI	FSC
Preliminary meetings	17	17	850	850
Pre-audit meetings and preparation	175	114	8,750	5,750
Documentation preparation and collection of evidence	216	107	10,800	5,350
Office visits by auditors	82	20	4,100	1,000
Field visits by auditors	110	52	5,500	2,600
Post audit work	264	26	13,200	1,300
Report analysis and response	0	0	0	0
Total hours spent and costs through initial certification	864	336	43,200	16,850

For the State of North Carolina, the total costs for SFI and FSC certification preparation were \$73,650 (\$1.65/acre) and \$29,950 (\$0.55/acre), respectively. The total combined cost for the certification preparation was \$103,600 or \$2.09 per acre. The portion of the total preparation costs attributable to Duke University with 8,000 acres of certified forests was \$9,750 for FSC and \$24,600 for SFI. The cost per acre for each program was \$1.22 and \$3.08 respectively.

Maine

The Maine Bureau of Parks and Lands did not track the hours separately for each certification system therefore they were split 50/50 between the two. Total direct preparation hours associated with the certification processes were 2,730 each for FSC and SFI. Using the same fixed wage plus fringe rate of \$50, the total direct preparation costs for each system was \$136,500. The combined cost for both certification systems was \$273,000 and the cost per acre was \$0.57.

Tennessee

The Forest Stewardship Council has certified the Tennessee state forest system. Direct preparation hours associated with the audit totaled 3,270 with a cost of \$163,500. The cost per acre for FSC preparation time was \$1.03. Although the state system has not been certified by SFI, Tennessee did incur 805 hours of preparation time associated with the pre-audit process.

Minnesota

As was the case for Tennessee, the Forest Stewardship Council has certified the state forests in Aitkin County Minnesota. A total of 850 hours were spent in preparation for the certification with a total cost of \$42,500. The cost per acre for the FSC audit preparation was \$0.08. At this time Minnesota does not have any public lands enrolled in the Sustainable Forestry Initiative program.

CERTIFICATION SUMMARY

North Carolina, Maine, Tennessee and Minnesota have 54,500 acres, 480,000 acres, 158,000 acres, and 550,000 acres of certified forests, respectively, for a combined total of 1,242,500 acres. Only two states, North Carolina and Maine have undergone third party certification from the Forest Stewardship Council and the Sustainable Forestry Initiative. Tennessee and Minnesota have undergone certification from the Forest Stewardship Council only, although Tennessee did go through the pre-audit phase with the Sustainable Forestry Initiative program.

Direct inspection costs for the individual forest owners ranged from \$30,000 to \$81,595 for FSC and from \$37,325 to \$67,000 for SFI. Preparation costs for FSC ranged from \$29,950 to \$136,500, and for SFI these costs ranged from \$40,250 to \$136,500. Total combined costs for SFI peaked at \$199,225 and for FSC the maximum was \$218,095. The minimum SFI total cost per individual forest owner was \$17,376 and for FSC the lowest cost incurred was \$30,650.

On a per acre basis, Minnesota incurred the least amount of costs associated with the FSC certification system. Maine followed with the least cost for FSC and incurred the least cost for SFI compared to the other states. FSC inspection cost per acre for Minnesota was \$0.05, whereas the per acre inspection costs for Maine was \$0.17 and \$0.13 for FSC and SFI respectively. Due to NC State's revisit by the auditors for the

initial assessment, the cost per acre was higher than the other North Carolina entities that were involved in the certification process. The SFI cost per acre for NCSU was \$3.77 and for FSC the cost per acre was \$4.82. Preparation costs per acre were also highest in the NCSU audit. SFI preparation costs per acre were \$7.90 and the FSC cost was \$3.73 per acre. The same relationship held true for the total costs incurred for the certification assessment.

The relationship between the size of each state's forest ownership and the costs incurred for the certification process was inversely proportional. Table 3 summarizes the ownership size/cost per acre relationship.

Table 3. Costs Per Acre by Ownership Size

Ownership	Ownership size (acres)	Total costs per acre	
		SFI	FSC
NC State University	4,500	\$11.67	\$8.55
Duke University	8,000	\$4.18	\$3.84
NC DENR	42,000	\$0.64	\$0.73
Tennessee	158,000	\$0.68*	\$1.35
Maine	480,000	\$0.41	\$0.45
Minnesota	550,000	N/A	\$0.13

***SFI pre-audit costs only, certification has not occurred.**

DISCUSSION

Certification Systems and Extent

The forest certification systems have perhaps the most rigorous standards in the world for forest management and protection. Probably many areas of the world already had high levels of management, but forest certification provides third-party audits of that management. Even if forest management is unchanged, public perception and acceptance increases with forest certification.

To date, the extent of certified forests is modest. There are approximately 120 million hectares of forest that are certified as of 2003, which makes up only 3% of the world's total forestland. Approximately 95% of the certified area is in the northern hemisphere, while about 95% of deforestation occurs in the southern hemisphere. The amount of certified forests has been increasing at a rate of about 10 million to 20 million hectares per year.

Also, there is an increasing extent of forest certification systems. These systems provide first as well as third party audits, with the majority being third party audits. Audit firms, such as Price Waterhouse and Smartwood, perform the actual certification inspections. Table 4 summarizes certification systems and the regions that they are most prevalent in. SFI is the largest system in the U.S. and Canada; FSC in Sweden, Eastern Europe, and Latin America; and PEFC in western Europe, Finland, and Norway.

Table 4. Certification Systems and Regions of Prevalence

Certification System	Regions of Prevalence
The Sustainable Forestry Initiative (SFI)	United States, some in Canada
The Canadian Standards Association (CSA)	Canada
The Forest Stewardship Council (FSC)	Sweden, Eastern Europe, Tropics (small)
Pan European Forest Certification (PEFC)	Western Europe, Finland, Norway
Some country unique systems	Malay, Indonesia, Brazil-CERFLOR, Australia

Other approaches include the Netherlands Keurhout Process, which is a 4th party audit system. The Dutch trade organization determines which major certification systems are credible for imports into the Netherlands and developing systems such as the American Tree Farm System and those in tropical countries.

Certification Costs - Preparation

Third party auditors performed all the audit inspections for Maine, Minnesota, Tennessee and North Carolina. Payments for the actual inspections ranged from \$30,000 to \$80,000. Audits for FSC certification appeared to carry the higher costs.

Much time was involved in the preparation for the audit and in the preparation of supporting documentation for the audit. Hours utilized for the audits performed in the above states were approximated from 200 to 3,300 hours. Based on the \$50/hour benefits plus wage rate used in the earlier analysis, preparation costs ranged from at least \$10,000 to \$165,000. The SFI audits appeared to require higher costs for preparation.

Additional costs were incurred by management changes that were recommended either prior to or after the initial audit. To receive SFI certification, almost all management changes had to be done in advance. Many of the conditions that resulted in management changes had to be met after FSC certification in order to maintain the certification designation.

Certification Costs – Inspection

There doesn't seem to be much difference between the initial inspection costs for SFI and FSC. Although for FSC, there may be more subsequent costs than for SFI. Also, for smaller tracts the initial costs are higher than for larger tracts.

In addition there are significant one-time costs for subsequent audits. For FSC there is an annual re-audit cost associated with certification and after 5 years a complete inspection is performed. SFI only requires a 3-year re-audit, therefore the costs are incurred every 3 years as opposed to each year as for FSC certification.

So far, the benefits for certification appear to be social in nature. Forest and landowners who have attained certification enjoy better public relations and there is more forester interaction within the management regime. Hopefully, future benefits of forest certification will be advantageous in the marketplace.

CONCLUSION

Forest certification is increasing worldwide. There has been continued progress by the major certification schemes and by individual countries in developing new schemes or introducing existing schemes. In contrast, some certificates have been withdrawn which implies rigor within the certification program. With this in mind, standards are continually upgraded and inspections are improved as well.

Still, forest certification is a long way from being universal. Only about 3% of the world's forests are presently certified. The availability of certified products is scarce. The costs involved with becoming certified are still greater than any premium price available for certified products. The shortfall of certified lands observed by the World Bank/WWF alliance indicates there are problems associated with increasing the extent of forestland certification.

The driving force behind attaining forest certification continues to provide managers and landowners with targets for performing excellent forest practices. As the desire for certified forest products continues and the desire to manage forest on a sustainable basis continues to grow, forest certification will be the basis for developing forest policy and designing research agendas.

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Who Owns World's Forests? Implications for Forest Production, Management, and Protection

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Abstract: Many discussions in forest resource policy relate to whether decisions regarding the production of forest outputs are more appropriately made by the private or the public sector. At least in principle, public forests are managed for public goods, which include a range of productive and protective uses, while private forests are managed for even a wider range of objectives that are central to their owners. We examine recent data on global and regional forest ownership, production, and protection and identify possible links between forest ownership and management outcomes. The vast majority of global forests, 87%, are owned by governments and other public bodies. Deforestation and forest decline take place primarily in public forests. This results from the lack of resources, expertise and workable regulatory approaches for managing public and private forests. Private forests and free markets work well in supplying industrial roundwood, while there is little evidence of lower management standards or widespread environmental damage. While market failures are often used to justify government ownership, widespread losses in government owned forests suggest that public policy failures are equally serious factors behind forest decline. This indicates that government ownership, rules and incentives must adapt to produce more private and public forest goods and services more efficiently and equitably.

Key Words: global forest resources, ownership, plantations, certification, sustainable forest management

INTRODUCTION

Ownership and tenure rights determine the ability to acquire, use, control and dispose a piece of property and product derived therefrom. They also greatly affect the ability of markets to allocate resources and to protect forests from destructive exploitation. Many discussions in forest resource policy relate to whether decisions regarding the production of forest outputs are more appropriately made by the private or the public sector. One must look at the values of market and nonmarket goods and services, and the success of the government or the private sector in providing them, in order to assess the merits of different ownership. Attempting to answer some of these questions, we examine the most recent data on global forest ownership and try to assess how well managed and protected are public and private forests across the world.

Forest Ownership Types and Tenure Rights Arrangements

Forests may be owned by firms or individuals in the private sector or by the public sector.

Public ownership describes the case when a government body exercises ownership jurisdiction over lands. Private ownership describes the situation where individuals, firms, businesses, corporations, or even nongovernmental organizations possess ownership rights to forests.

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Ownership implies that an entity claims land tenure rights to a forest. Tenure rights are the ability to acquire, use, control and dispose of a piece of property—either the land itself or the produce derived therefrom. They are fundamental in determining how forests will be managed, protected, or neglected. Tenure rights are often, but not always, exclusive. They are seldom absolute. The government has the power to determine the tenure rights to a piece of property. They may assign all control above and below the surface to the owner of a piece of land, or they may only allow partial uses, such as rights to the timber or nontimber forest products but not to the mineral or oil products. They may allow personal use only or selected commercial uses, and they may be restricted by zoning or tax controls. Landowners may be allowed to sell some development rights, so that the land remains in a natural state. The government may also choose the purchase of development, harvest and other rights where private owners are compensated for providing particular products and services. The government may also decide to pay for public goods and environmental services.

It is possible for the government or the private sector to exercise strong tenure rights and control over forestland. On the one extreme, the government may rely on unregulated private ownership and free market, which is rare. Even in the United States where private forests dominate the sector that relies on free markets, the government regulates forestry. In order to promote the production of socially desirable services, the government may provide technical or financial assistance or both to private forest owners. The Forest Stewardship Program and the Stewardship Incentives Program are examples of such approaches in the United States. In the other extreme, the government may institute public ownership, management and production as is the case in some European countries and elsewhere. Tenure rights change periodically as governments evolve, such as actions to privatize forests in New Zealand and South Africa demonstrate, or increasing laws that restrict forest practices in the United States exemplify.

Various intermediate forms of forestland, timber, or other product ownerships may exist. Nongovernment organizations often own forestland in order to maximize environmental benefits. Costa Rica has entered into agreements with pharmaceutical companies for prospecting and patent rights to medicinal plants. The USDA Forest Service owns public land, but leases it for ski resorts. Large individual investors and timber management organizations lease land to forest products firms. Hunting leases are common throughout Europe and North America. These intermediate mechanisms provide various means to allocate the rights to the use and disposition of forest goods and services in manners that compensate the various owners adequately for their capital, labor and entrepreneurial efforts.

In addition to various ownership strategies, forestland owners may employ a variety of management approaches. Governments may employ their own forest managers to plan, monitor, manage and protect their land. So might individuals, at least on a part-time basis as needed for specific projects. Companies may employ their own personnel; hire consultants on a contract basis; or lease land to other management firms. Again, these various arrangements provide means for forestland owners to exercise adequate control over their land at reasonable costs. In some cases, control and management may be extensive, or even ineffective, if firms or governments do not have adequate capital or budgets. Forests have usually been less valuable than more intensive land uses, and harder to exercise control over at reasonable costs.

Global Forest Ownership

The world's forests are owned primarily by governments and other public bodies (Table 1). We used data from the Temperate and Boreal Forest Resources Assessment 2000 (UNECE 2000), White and Martin (2002), and Hyde et al. (in press) as well as our own estimates to assess global forest ownership. We compiled forest ownership information for about 85% of global forest area. Community forests covering 200 million ha are classified as government, but they could be considered as large groups of private individuals—less formal than most governments. Overall, about 87% of the forests (3.4 billion ha) are in public ownership. In Africa virtually all forests are in public hands. The share of private forests in other regions varies from 6% in Asia to 36% in North America. In total, private forest ownership comprises only about 500 million ha of forests.

While public ownership predominates, forest ownership structure varies substantially throughout the world. In Europe, for example, all forests are publicly owned in the Russian Federation and other countries of the Commonwealth of Independent States (CIS). Public forests also dominate in many former communist countries in Central and Eastern Europe, including Czech Republic (84%), Poland (83%) and Romania (95%). Some countries in Western Europe also have large public forests, including Germany (54%), Greece (77%), Ireland (66%) and Switzerland (68%). Private forest ownership dominates in Austria, Denmark, Finland, France, Norway, Portugal, Slovenia, Spain and Sweden, which all have about 70% or more of their forests privately owned.

Table 1. Forest Ownership Statistics by Region

Region	Total Forest Area (000 ha)	Forest in Public Ownership ¹ (%)	Ownership Data Coverage (%)
Africa	649,866	100	47
Asia	547,793	94	80
Oceania	197,623	84	99
Europe	1,039,251	90	100
North America	470,564	64	100
Central America	78,740	85	70
South America	885,618	86	91
World	3,869,455	87	85

¹ Included in public ownership are 200 million ha of tribal and communal forests (5%).

The United States is unique among countries with large forest resource endowments because of the dominant role of private forests. Forestland ownership in the United States can be classified into four broad classes: National Forest, Other Public, Forest Industry and Nonindustrial Private. National Forests contain 23% of all forests, primarily in the West where the majority of National Forests were established (Smith et al. 2001). Other Public ownership includes all forests managed by public agencies other than the USDA Forest Service. These include the Bureau of Land Management, states, counties, and municipalities, which together control about 12% of forests. Primary wood products manufacturers, classified as Forest Industry, own about 12% of forests. Nonindustrial Private Forest (NIPF) ownership includes individuals, trusts and

corporations, which control about 53% of forests. In total, then, private owners control 65% of forests in the country. Private ownership is even more important in the U.S. South where it covers 88% of forestland, with NIPFs accounting for 70% of forestland and Forest Industry for another 18%.

Forest Ownership and Management Objectives

Forest ownership is important because the owners usually determine the objectives for the use of forestland and its associated resources. The owner establishes management policies and provides the means to achieve them. Public ownership relies on government agencies in formulating and implementing policies affecting these forests. Private ownership gives management responsibility to individual owners or corporations or trusts.

The government relies mostly on the policy-making process where decisions regarding programs and budgets are politically determined, although market prices and costs of goods and services are considered in decision-making. Public forests are managed, at least in principle, for public welfare. Multiple uses and environmental services often receive more emphasis than wood production. The focus is on common and toll goods such as open range or recreation in national parks. Goods characterized by joint consumption are less likely to be satisfactorily allocated in markets because there is no market price. Therefore, larger government involvement may be appropriate for making decisions with respect to these goods and services.

Private forests are managed for financial or utility benefits of their owners. The private sector relies on prices determined in markets, along a good bit of governmental regulation. Private and toll goods such as timber or hunting leases dominate, while environmental services are produced as external benefits or costs. Still, private forests provide a wide range of uses and benefits, including timber, watershed maintenance, soil retention, range potential, wildlife habitat and recreation opportunities.

In the United States, for example, private industrial owners manage their land primarily for timber. Despite timber management's predominance, nontimber uses are recognized in forest management through best management practices and forest certification. In the end, these industrial forests produce timber while supporting a range of nontimber uses. NIPF owners are much less uniform in their approaches to forest management. They have multiple objectives and their actions are more complex than industrial owners. NIPF management approaches range from very intensive timber management, similar to the industrial owners, to an entire disregard of forest management for any purpose, productive or protective. NIPF owners who value nontimber benefits are less likely to manage their forests for timber production if it reduces these uses. NIPF owners may extend rotations if nontimber services increase with forest age and volume.

Forest management and protection in private forests

As often implicitly assumed, public forests management is geared towards environmental services and important social objectives, while private forests management is more frequently geared towards timber production and private owner objectives. Private forest management is also often perceived as less socially responsible and characterized by lower environmental standards.

Information about management and protection in private and public forests across the world is scarce. Fairly reliable statistics published for the private forestry sector in the United States permit some comparisons with the rest of the world. In 2000, the

United States accounted for only 6% of global forestland area, 8% of timber inventory, and 12% of forest plantations (Smith et al. 2001, FAO 2001). These resources produce 27% of global industrial roundwood. The information for the U.S. South is even more telling; the region that accounts for only 2% of each global forestland and timber inventory, supplied about 18% of global industrial roundwood, much of it grown in plantations. This indicates that private forests may be more efficient in supplying timber outputs than public forests and that free markets may work well in providing industrial roundwood as well as other private goods and services.

The existence of forest management plans indicates various levels of planning and management activities. The Forest Resource Assessment (FRA) 2000 defines the area under forest management plan as the area managed for various purposes, such as productive or protective uses, in line with approved national plans covering 5-year periods or more (FAO 2001). For developed countries, this category also includes informal management plans. Overall, FRA data suggest that about 43% of all forests across the world have some type of management plan. The U.S. share is higher and equals 56%.

FAO forest protection data as well as certification information allow some inferences about how private and public forests management addresses a range of environmental issues. In order to estimate protected forest area, FAO overlaid global forest cover maps and maps of protected areas with a legal protection status (FAO 2001). Protected areas include nature preserves, wilderness areas, national parks, natural monuments, protected landscape and managed resource protection areas. The objectives for managing protected lands focus on conservation and protection of natural functions, values and biodiversity. In total, FAO estimates that about 12% of the world's forests are legally protected, but the statutory levels of protection surely have different levels of enforcement. By comparison, in the United States about 40% of forestland, mostly public, receives some form of protection.

Forest certification may also indicate a drive towards more sustainable forest management and better forest protection. We collected information on certified forest area from the web sites for each of major certification organizations in the world (which encompass forest management systems and third party auditing), including American Tree Farm Program (ATFP), Canadian Standard Association (CSA) National Standard for Sustainable Forest Management, Forest Stewardship Council (FSC), Pan-European Forest Certification Council (PEFCC), Sustainable Forest Initiative (SFI), Malaysian Timber Certification Council (MTCC), and Green Tag (GT). In 2000, only 2% of forests were certified worldwide. At the same time, 11% of U.S. forests, mainly private, were certified.

In summary, the data indicate that at least in the case of the United States private forests are well managed as measured by their production, the existence of management plans and extent of forest certification. There is little or no evidence of lower management standards and widespread environmental damage. However, private forests managed for timber production probably are less biologically diverse and provide fewer environmental benefits.

How well does government ownership protect forests?

While public forest management, at least in principle, aspires to high environmental standards and important social objectives, global data on the status of forest resources do not entirely support this point.

FAO data indicate that despite growing conservation efforts, the decline in global forest area has continued. It is estimated that between 1980 and 1995 about 180 million ha of forests were lost, which represents an area larger than Mexico or Indonesia (FAO 1997). The current net annual deforestation rate (natural forests loss offset by planted forests gain) is estimated at 9 million ha annually (FAO 2001). The total loss of the world's natural forests, which comprises deforestation and conversion to planted forests, is larger and estimated at about 16 million ha. Most natural forests, 94%, are lost in the tropics, where public forest ownership is dominant. Major causes include growing populations and income resulting in ever increasing demand for wood and land for agriculture and for development. Forest decline has a broader meaning that goes beyond forestland loss and encompasses the decline in quality of existing forests resulting from overexploitation, fragmentation, and human set fires. The extent of this process is largely unknown.

Since the vast majority of forests are government owned, deforestation and decline also take place primarily in government owned forests. These problems are exacerbated by wood output structure in which fuelwood, frequently produced from natural forests under public ownership, dominates. The link between government ownership and forest decline may result from a variety of reasons. The government may convert forests to other uses to promote the achievement of social and development goals, which in some cases are justified and increase social welfare. In many situations, the government simply lacks resources and expertise to adequately manage its forest resources. Yet in other cases, poor government policies or corruption lead to forest destruction. Forestland loss and degradation clearly point to the continued need to examine the role of government ownership, policies and management approaches, and their success or failure in promoting sustainable forest management.

While market failures are often used to justify government ownership, widespread losses in government owned forests suggest that government policy failures are equally serious factors behind forest decline. In situations where governments lack resources and are unable to develop workable approaches to managing their forests, a greater reliance on private or communal property and free markets may be considered. When considering forest ownership changes, the whole process should amount to more than just a transfer of property rights; it should improve the quality of forest management. To date, the results of such ownership changes have been mixed.

In Central and Eastern Europe, forest restitution (the return of nationalized private forests to their former owners) has sometimes resulted in neglect and forest overexploitation, due to unfavorable regulations and lack of management incentives, and created very fragmented ownership with limited potential for improved management (Siry 2002). In China, the results are also mixed, depending on the quality of local regulations and incentives for better management (Hyde et al., in press). These are fairly recent efforts and more time will have to pass before evaluating their long term effects. Present outcomes only underlie the importance and need to develop effective legal, institutional, and economic framework for forest conservation and sustainable management, which remains a challenge in many countries.

CONCLUSION

The vast majority of global forests, 87%, are in public ownership. In the United States 65% of the forests is private, and in the U.S. South the share of private forests reaches 88%. Private forests' role in industrial roundwood production is increasing.

Much of wood volume is harvested from planted forests, where sustainability of harvest is generally accepted, although long-term multiple rotations still need evaluation. Fuelwood, on the other hand, is primarily produced from publicly owned natural forests, making the sustainability of harvest and forest management a major concern.

There is little evidence of lower management standards or widespread environmental damage in private forests. Private forests geared towards industrial roundwood production probably provide less biodiversity and environmental benefits. Financial incentives may be required to induce private forest owners to produce more desired environmental benefits. Public forests tend to focus their management on dispersed recreation, amenities and fuelwood. While public ownership has protected large areas from exploitation, in many regions poor management, overexploitation and environmental damage remain a problem. Public forest management is often impeded by government agencies seeking to maximize their budgets and influence, while public oversight and market and business checks are modest. Further, even if laws, management and intentions are good, budgetary and personnel constraints remain a problem.

It is apparent that markets work well in providing industrial forest products and other private goods and services, while public lands can ensure access and rights for local people and national interests. While market failures are often used to justify government ownership, widespread losses in government owned forests suggest that public policy failures are equally serious factors behind forest decline. This indicates that government ownership, rules and incentives must adapt to produce more private and public forest goods and services more efficiently and equitably.

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The Costs of BMP/SFI Compliance: Arkansas Loggers' Perspectives

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Abstract: This study presents the results of an Arkansas survey of loggers regarding the costs of their adherence to Arkansas Best Management Practices (BMPs) and Sustainable Forestry Initiative (SFI) principles. The survey comprised of questions on monetary and other costs of BMP/SFI compliance, frequency of BMPs implemented, and participation in BMP training sessions; as well as general questions on types of logging jobs, level of production, and equipments. Analysis of the survey data revealed that the most expensive BMP/SFI requirement for the loggers was brush cutting followed by constructing waterbars, wing ditches, road resurfacing and others. The most time consuming BMP, on the other hand, was revegetation, followed by constructing waterbars, wing ditches, and others.

Key Words: Best Management Practices, Sustainable Forestry Initiative, Arkansas loggers, cost of forestry operations.

INTRODUCTION

Costs associated with forestry operations have always been of particular interest to economists. This includes traditional forestry operations such as site preparation, planting, fertilization, competition control, thinning, harvesting and transportation. However, there are also operations or measures that may not be essential, but are either required by law, or are simply accepted as good forestry practices. Examining the costs and benefits of such practices has always intrigued economists because of their potential impact to both industry and the society. Best Management Practices (BMPs), generally referred to a set of guidelines designed to protect water quality, are examples of such practices. BMPs have their roots in the federal Clean Water Act, and they originated as the Environmental Protection Agency (EPA) delegated some of the non-point source water pollution protection responsibilities to the states. While a handful of the states made BMPs mandatory, most (including Arkansas) opted for these guidelines to be voluntary. The word “voluntary” in this case, however, can be rather misleading. Other events in the policy arena have in fact made BMPs *de facto* mandatory. For example, much of the forest products industry has signed on to the Sustainable Forestry Initiative (SFI), which requires compliance with BMPs. A timber producer, therefore, would not be able to deliver timber to an SFI certified firm without complying with SFI requirements. This effectively results in serious restrictions on available options for a timber producer. Adherence to BMPs is obviously not without cost. Like any other operation, there are costs associated with implementing BMPs, and currently there is no structure in place to internalize these costs. Due to competition and the voluntary nature of BMPs in most states, the price of timber generally does not reflect these costs. It appears that, at least for now, timber producers are left with no choice but to absorb these costs.

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It is important to note that BMP implementation also has benefits. These regulations or guidelines (depending on whether BMPs are mandatory or voluntary) are designed to protect water quality and minimize soil erosion. There are certainly benefits from such protection to a landowner, and to the society. However, much like the costs, there exists no structure for internalizing the benefits as well. According to economic theory, in the absence of such structures, economic inefficiencies will occur. While it is important to remember the benefits, the focus of this article, however, is the costs of BMP implementation.

Due to these characteristics mentioned in the preceding paragraphs, BMPs have attracted substantial attention from economists and policy analysts. Studies on this issue ranges from compliance monitoring (Ellefson et. al. 2001), analyses of costs and benefits (Blinn, et. al. 2001; Haney et. al. 2001; Shaffer and Aust 1999; Worrell et. al. 1999; Shaffer et. al. 1998; Kluender et. al. 1997), comparison of voluntary and mandatory BMPs (Shaffer and Aust 1994; Shaffer and Aust 1993a; Shaffer and Aust 1993b), and analyses of BMPs as a policy measure (Rice 1992; Cubbage and DeForest 1991; DeForest et. al. 1990).

This study originated from our interest in performing time and motion studies and economic welfare analyses of BMP implementation in Arkansas. Since no previous study of Arkansas loggers regarding BMPs exist, we decided to conduct a survey of Arkansas loggers in order to understand their perception of the costs of BMP implementation. Therefore the objectives of the study were twofold. 1) To compile and understand Arkansas loggers' perception of costs involved in BMP implementation. 2) Collect information on Arkansas loggers that can serve as a baseline for future studies.

THE SURVEY

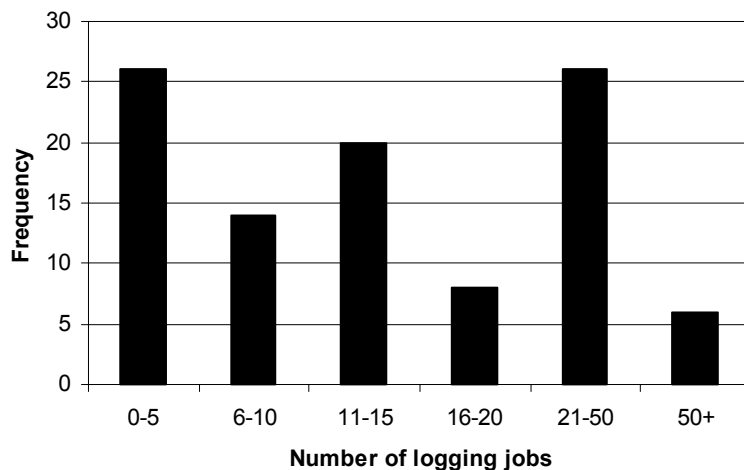
Loggers listed on the Arkansas Timber Producers' Association (ATPA) roster were the participants in this study. The ATPA list contained 276 members as loggers. Each of these individuals was mailed a BMP/SFI survey instrument in Fall of 2002. The survey consisted of an introduction letter, survey, and stamped, self-addressed return envelope. The survey was followed by a reminder post card. Two of the surveys were undeliverable. Fifty-four people returned their survey, of these returned surveys, five were unusable. The response rate was approximately 20 percent. All non-respondents were contacted by phone and asked if they would participate in the study. Twelve respondents stated that they did not wish to participate in the study. Those who responded positively (n=39) were sent a subsequent survey, introduction letter, and stamped self-addressed return envelope. If the respondent still did not return his/her survey, another phone call and survey mailing followed. A total of 11 surveys were received from non-respondents. Although the response from non-respondents was low, their responses were not significantly different than those of the respondents.

The survey included a variety of questions regarding the respondents' logging operations. The first part of the survey contained general questions on the respondent's business such as number of jobs owned and completed in 2001, minimum and maximum production, types of land ownership, distribution of logging jobs based on physiographic regions, Number of full-time and part-time employees, and the type of equipment owned. The second part of the survey included specific questions on the impacts of BMP compliance on the respondent's business practices.

SURVEY RESULTS AND DISCUSSION

Figure 1 represents the number of logging jobs completed by the respondents of this survey. The question regarding the number of logging jobs owned had apparently caused some confusion among the loggers. We later determined that this was probably due to the use of the word “owned”. The answers to this question showed a pattern of inconsistency and therefore we decided to disregard the responses to the question. Figure 1 reveals that roughly a quarter of the respondents had completed either between 0-5 or 21-50 logging jobs. Another fifth completed between 11 and 15 jobs. It is important to note that these figures do not imply anything about the relative size of those jobs, or the size of the respondent’s operation. Since these two factors are implicitly variable within these figures, they should be treated carefully. However, from Figure 1 we still get an idea of the diverse nature of logging operations in terms of scale. The survey clearly included large-scale logging companies, as well as so-called “mom and pop” operations. Further insight into the scale issue was gained through the questions regarding their handling of multiple logging jobs at a time. About 46 percent of the loggers affirmed that they did handle multiple jobs at the same time in 2001. About 42 percent of the loggers said that they typically handle 2 logging jobs at the same time. When asked about the maximum number of jobs ever handled at the same time, about 42 percent said that they had handled more than 5 jobs at a time in the past.

Figure 1. Number of logging jobs completed in 2001.



The survey contained several questions regarding production from logging jobs. When asked about the loggers’ minimum production per job in 2001, there seemed to be an even distribution with the average being between 500 and 1,000 tons (Figure 2). Approximately 28 percent of the loggers said that their minimum production from a job was between 500 and 1,000 tons. Indeed most of the respondents, about 61 percent had put their minimum production from a logging job in 2001 at 500 tons or more. When asked about maximum production from a job, 35 percent chose between 1 and 5 thousand tons, while 25 percent said it was between 5 and 10 thousand tons (Figure 3). A substantial proportion, about 16 percent, said their maximum production was in excess of 50 thousand tons. Average total production for the year 2001 was between 50 and 100 thousand tons (Figure 4).

Figure 2. Minimum production per logging job, 2001.

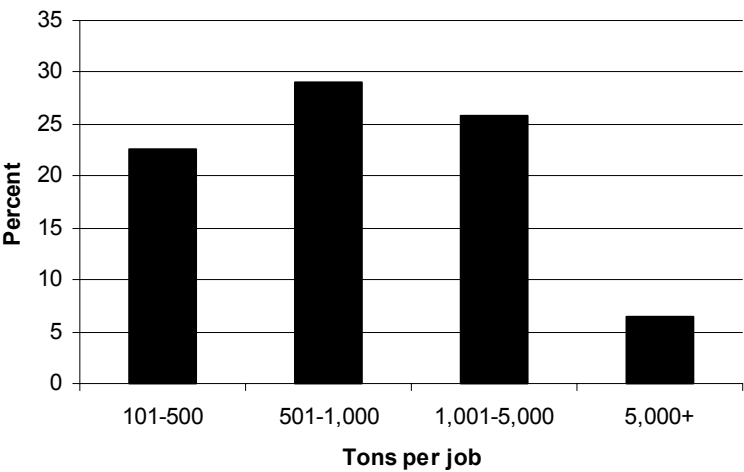


Figure 3. Maximum production per logging job, 2001.

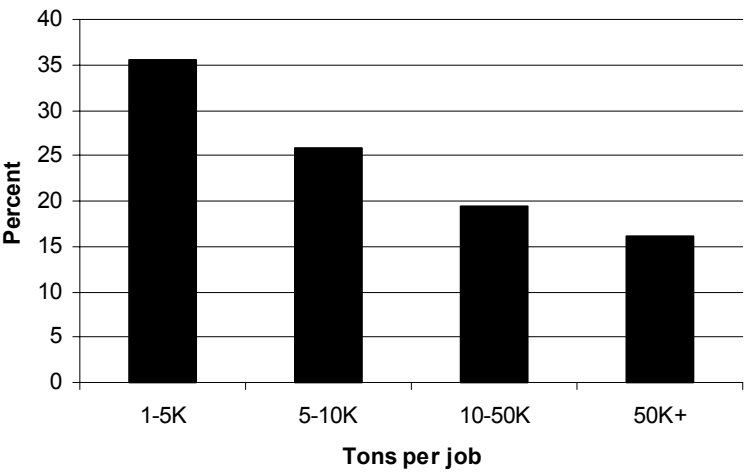
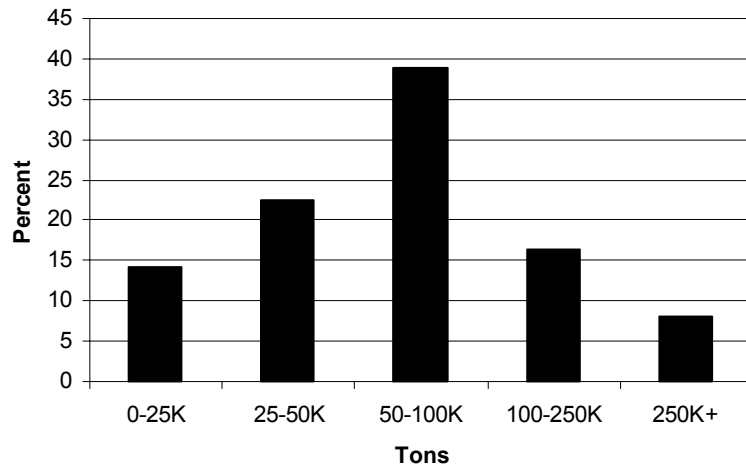


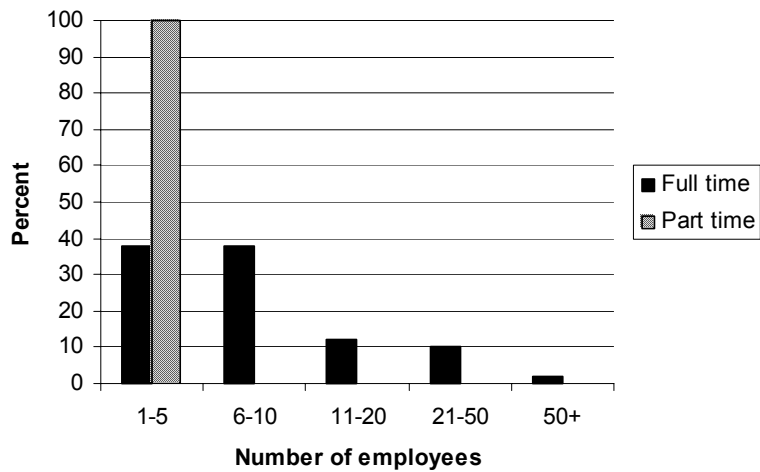
Figure 4. Total production from logging jobs, 2001.



When asked about the type of ownership of the land that they worked on, about half of the respondents said between 75 and 100 percent of their jobs were on NIPF land. Almost exactly the same proportion of respondents gave the same response about industry lands. More than 90 percent of the respondents had only a quarter or less of their jobs on public lands. On a regional basis most of the logging jobs were in the Coastal Plain region of the state. This was no surprise since that is in fact the pine growing part of the state. Almost 90 of the loggers had between 75 and 100 percent of their jobs in the Coastal Plain region. Between 50 and 70 percent of the respondents had only a quarter or less of their jobs in the Delta, Ouachita, or Ozark regions.

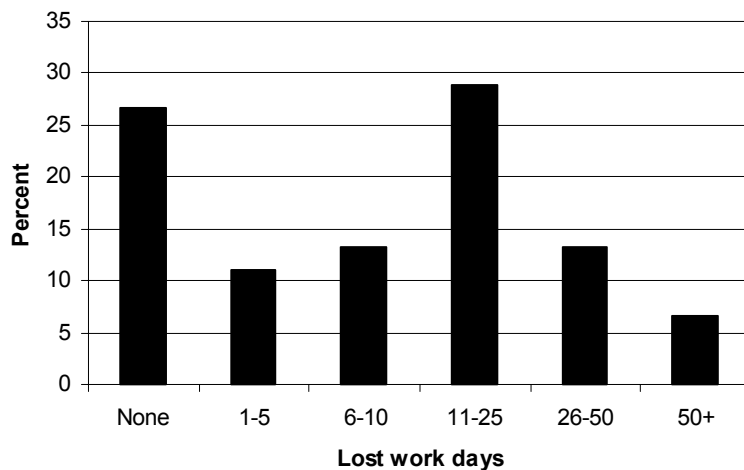
For any firm, the number of employees is an indicator of size. Number of employees is also an important determinant of cost. About 37 percent of the respondents said they had either between 1 and 5 or 6 and 10 full-time employees (Figure 5). About 12 and 10 percent of the loggers had 11-20 and 21-50 full-time employees, respectively. A much smaller proportion, about 3 percent, had more than 50 full-time employees. All of the respondents had 5 or less part-time employees.

Figure 5. Number of employees, 2001.



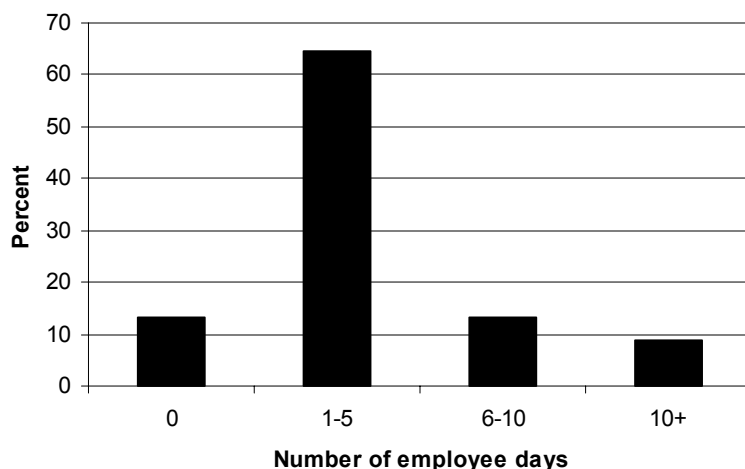
In order to understand the cost impacts of BMP implementation, several questions were asked. When asked about lost work-days due to BMP implementation, 26 percent said they had not encountered any such loss (Figure 6). However, about 29 percent estimated that they had lost between 11 and 25 days due to following BMPs in 2001. Between 10 and 15 percent respondents opted for 1-5, 6-10, or 26-50 days. About 7 percent gave somewhat of a large estimate of 50 lost work-days in 2001 due to BMPs. This, however, is not a surprise. Due to cost implications, some loggers are unhappy about having to bear the costs of BMPs. This may have influenced their estimate of lost work-days.

Figure 6. Number of lost work days due to BMP/SFI compliance, 2001.



Many forest products industries require loggers to attend BMP training sessions. Sending their employees to these training sessions also imposes a cost on the loggers since they still have to pay these employees for the time they spend in training. When asked about the number of employee-days spent on BMP training, majority of the loggers (65 percent) estimated it to be between 1 and 5 employee-days (Figure 7). About 12 percent had not spent any employee-days on training, while an equal number spent between 6 and 10 days. About 9 percent of the loggers spent more than 10 employee-days on BMP training. On a related note, about 70 percent of the loggers had sent between 1 to 5 employees per training session.

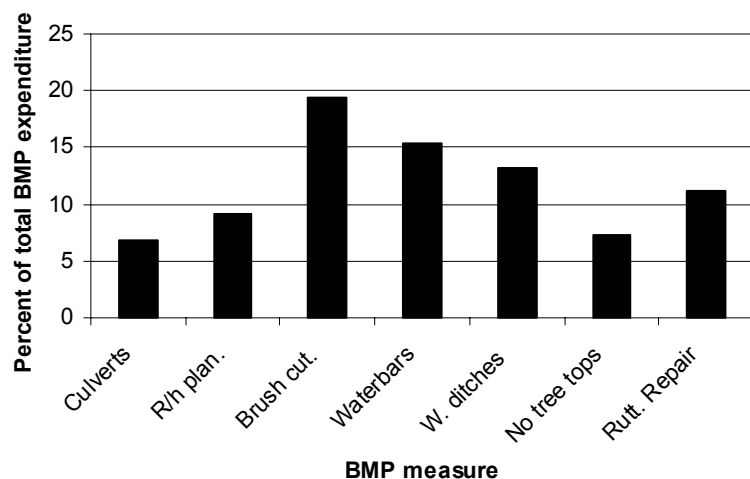
Figure 7. Number of employee-days spent on BMP training, 2001.



Another important factor as far as costs are concerned is the terrain type. On a marginal basis, it is more expensive to operate on mountainous terrains. Most of the logging jobs appeared to be on relatively flat terrain. Between 60 and 70 percent of the loggers had a quarter or less of their jobs in mountainous, hilly, or bottomland terrain in 2001. On average about a quarter of the loggers had between 26 and 50 percent of their jobs in mountainous, hilly, or bottomland terrain. Not surprisingly, very few (5 percent or less) respondents had 75 percent or more of their jobs on mountainous, hilly, or bottomland terrain.

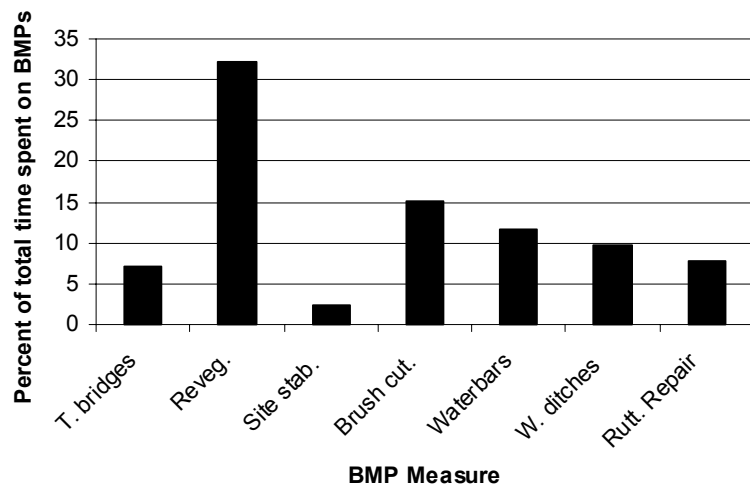
In terms of frequency, the most frequently used BMP measure was avoiding tree tops from stream channels. About 85 percent of the loggers had employed this measure in all of their jobs. Between 40 and 45 percent had used road planning or building waterbars in all of their jobs. Loggers were asked to estimate costs in dollar values for BMP measures employed. In order to analyze costs of different BMPs, these dollar values were added for all respondents by BMP measure. These total values for each BMP gave us the total amount spent across all respondents for each BMP measure. Figure 8 presents the percent share for these values of the grand total for the 7 most expensive BMPs. Brush cutting (commonly known as bush hogging), was the most expensive BMP having a share of 19 percent of the total amount spent by all loggers on BMPs in 2001. Other expensive BMPs were building waterbars (15%), wing ditches (13%), rutting repair (11%), road planning (9%), avoiding tree tops from streams (7%), and culverts (7%).

Figure 8. Percent share of total expenditure by all respondents on BMP measures, 2001.



The loggers were also asked to estimate the amount of time spent for each of the BMPs. Total time spent for each of the BMPs across all respondents was found in exactly the same manner as in the previous case. In terms of total time spent, revegetation was the most demanding taking 32 percent of the total time spent by all respondents on BMPs in 2001 (Figure 9). Other BMP measures were not nearly as time consuming and included brush cutting (15%), building waterbars (11%), wing ditches (10%), rutting repair (8%), temporary bridges (7%), and site stabilization (2%).

Figure 9. Percent share of total time spent by all respondents on BMP measures, 2001.



CONCLUSIONS

The objective of this study was to better understand and gather some basic information about the loggers' perspective on the costs of BMP/SFI compliance in Arkansas. Based on the survey, road/harvest planning, site stabilization/erosion control, waterbars, and keeping tree tops out of streams appeared to be the most frequently used BMP measures. Brush/slash cutting was the most expensive measure to implement, followed by waterbars, wing ditches, and repair of rutting/road resurfacing. Although brush cutting is not a part of the BMP guidelines in Arkansas, it is however a part of SFI requirements for aesthetics and revegetation. In terms of time spent, re-vegetation was by far the most time consuming, followed by brush/slash cutting, waterbars, wing ditches, and repair of rutting/road resurfacing. These results provide us with information necessary to better understand the cost structure involved in Arkansas loggers' compliance to BMP/SFI guidelines. Such information will be crucial for planning future research in this area. In addition, this information may also be useful to policy makers for refining BMP guidelines, or for developing policies aimed at internalizing the costs of BMP/SFI compliance. The results will also be useful to timber producers for developing their strategies on how to approach policy makers.

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Forest Stewardship Council Certification Conditions, Management Impacts, and Costs for NC State University College Forests

Allan Marsinko¹, Frederick Cubbage, Joe Cox, and Susan Moore²

Abstract: NC State University underwent the Forest Stewardship Council (FSC) certification process on the college forests in 2001. The process identified 23 conditions that require action by NC State in order to meet the requirements for continued certification. In order to satisfy the conditions, NC State will incur costs and will alter the management plan for the forests. This study analyzed each of the 23 conditions and attempted to identify the types of costs associated with each. A rough estimate of the magnitude of the costs was made for each condition. The effect of each condition on the workload of the forest manager and other forest personnel was estimated.

Key Words: Forest certification, FSC, certification cost

INTRODUCTION

Forest certification is a controversial issue with advocates who often view it as a positive means to respond to environmental critics of forest management; an excellent means to demonstrate good forest management; and a platform for adaptive forest management (e.g., Mater 2001, Mater et al. 2002). Critics of certification cite high financial costs, undesirable social agendas, and no price benefits for landowners (e.g. Caulfield et al. 2001, Vardaman 2001). Certification is the process in which a forest owner voluntarily requests an independent certification body to inspect his or her forest land (Viana et al 1996). The certifier visits the forest site and determines whether the management meets clearly defined standards and criteria. During the period May through December 2001, NC State University underwent the Forest Stewardship Council (FSC) certification process on the college forests. The process identified 23 conditions that require action by NC State in order to meet the requirements for continued certification. In order to satisfy the conditions, NC State will incur costs and will alter the management plan for the forests. Although the cost of conducting the certification process is easily determined, costs associated with implementation of the process (satisfying the conditions), are often difficult to identify and estimate. This study analyzed each of the 23 conditions and attempted to identify the types of costs associated with each. A rough estimate of the magnitude of the costs was made for each condition. The effect of each condition on the workload of the forest manager and other forest personnel was estimated. Several of the conditions have the potential to affect the long-term management of the forests. These were analyzed in more detail and their effect was estimated. One such condition addressed “exceeding” BMP requirements regarding buffer strips along streams. Due to space limitations, this paper will address all of the conditions but will limit detailed discussions to a few.

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NC State University has five forests scattered across several counties in the Piedmont, with two comprised mostly of loblolly pine plantations, and three comprised of natural hardwoods and pines with some plantations. These forests total approximately 4500 acres and have a forest manager paid from state funds who oversees their management. The forests are managed with multiple objectives, including education, research, income generation, and recreation. Income from forest management activities funds operating costs, including costs of providing recreation and some student scholarships. Thus, cost increases associated with certification affect the provision of services from the forests.

METHODS

A qualitative approach was used to analyze the 23 conditions and identify the types of costs associated with each. The approach involved an iterative process that began with discussions with appropriate NC State personnel. Then, each condition was examined and an attempt was made to determine specifically how it would be satisfied. At this time, estimates were made of one time and recurring costs associated with satisfying each condition. One time and recurring time commitments by the forest manager and other personnel were also estimated. These estimates were categorical (i.e. very low, low, moderate, high). Attempts were also made to identify types of opportunity costs that might occur as a result of satisfying each condition. A document was then prepared and submitted for review by college personnel. The document was revised based on the results of the review and further discussions with appropriate personnel. The review and revision process was repeated. A GIS-based quantitative approach was used to analyze the effect of exceeding BMP requirements.

Analysis of the 23 conditions was based on all of the NC State University forests (4500 acres). The GIS-based quantitative approach used to analyze the effect of exceeding BMP requirements was based on a portion of the Hill forest (one of the five forests that comprise the NC State University forest) for which detailed data were available.

RESULTS

The conditions range from simple and low cost to ambiguous with a potentially high cost of implementation. Because a detailed analysis of all 23 conditions is beyond the scope of this paper, we present this section of the paper in the following way. First, a detailed written analysis of four of the conditions is presented. These conditions cover the ranges of complexity, cost, and ambiguity inherent in the 23 conditions. This approach should give some insight into the process we used to determine how the conditions could be satisfied. Then, a summary of estimated costs and time requirements of all 23 conditions is presented. Finally, the GIS-based analysis of a condition involving BMPs is shown.

Detailed analysis of conditions

The first condition we present (condition 3) is straightforward and low in cost. It is stated below as it appears in the document resulting from the certification process (Jones et al. 2001). The criteria listed at the end of each condition are criteria on which each condition is based and are listed in the certification document. Thus, analysis of the conditions involved interpretation of the condition along with a review of the appropriate

criteria. Some of the conditions were ambiguous and could be interpreted in several ways.

Condition 3: Within one year of the issuance of a certificate, NCSU's College Forests shall develop a policy for informing faculty and graduate students of the potential hazards in the forest, the need for considering safety equipment when performing research, and for providing notification of major undertakings in the College Forests to the Forest Manager. (Criteria 4.4.2, 4.4.4 and 4.4.5)

Informing faculty and graduate students could consist of preparing a document to hand (or email) to graduate students and faculty who will work on the forest. In this case the costs would consist of a one-time cost of preparing the document and a low recurring cost associated with distributing the document. The costs of notifying the forest manager of major undertakings are also low and are recurring costs most likely born by the faculty. The forest manager or an assistant would likely file this information in a database linked to the forest GIS. Because this process is currently being used in an informal way, the costs of meeting this part of the condition are relatively low and are due to formalizing the process.

Condition 8: Within one year of the issuance of a certificate, NCSU's College Forests shall develop and implement a policy indicating how green tree retention will be used in even-aged management units for purposes of maintaining vertical structure and providing refugia within stands. (Criterion 4.6.3)

The basis for green tree retention will be the size of the clearcut and the availability of possible retention trees. This condition will probably require development of criterion concerning what to retain, how to identify these trees prior to the harvest, and how to mark them so they will be retained during the harvest. This involves what will probably be a moderate one-time cost of the forest manager's time for development and a low to moderate recurring time cost for implementation, evaluation of harvest blocks prior to harvest, and inspection to ensure that the logger does not cut the trees. Criterion 4.6.3 states "Additionally, there has been little consideration for the use of green tree retention within harvest units for the purposes of providing vertical structure and refugia for short range, non-game wildlife species ". This implies that green tree retention has not occurred on a regular basis in the past. Any increase in green tree retention will likely result in an opportunity cost due to the space these trees will occupy and/or resulting harvest delays for this space. The magnitude of this opportunity cost will depend on the degree of green tree retention, including the size and quality of the trees left standing.

Condition 18: Within three years of the issuance of a certificate, NCSU's College Forests shall, within the Plan of Management, further describe how the monitoring of neotropical migratory bird species on the Hill Demonstration Forest and snag retention/coarse woody debris data are being used to improve the strategic planning of the forest. (Criterion 4.8.4)

These data are available because they have been collected in the past and are expected to be collected in the future. Therefore, there is no additional cost associated with collecting additional data. Thus, action consists of incorporating this information in the management plan and, possibly altering some management activities to comply with the "are being used" part of this condition. Because NC State has been given three years to accomplish this, it is likely that some management activities will change as a result of

this condition. Costs include a one-time investment of the forest manager's time to specify how the data are being used and to incorporate this information into the management plan as well as a low recurring cost to update this component of the plan. If management activities change, there may be an opportunity cost associated with the changes.

There are several approaches to using these data in the strategic planning process. The least cost approach would use the current inventory and species mix of birds and snags (depending on available variables) as a target. If a statistical analysis of historical data shows little or no change in the inventory mix over the years, then the current management plan would be justified and followed in the future. Then, monitoring would consist of collecting data periodically to determine whether changes have occurred. If changes have not occurred, continuation of the current plan is warranted. If changes have occurred, then it is the responsibility of the forest manager to determine what caused the changes and to attempt to correct them if necessary (or to reassess the situation). A problem could arise if the initial statistical analysis showed a historical change in the inventory of birds. If the change were found to be negative (e.g. fewer species and numbers of birds), the manager would have an immediate problem to contend with. If the change were found to be positive (e.g. greater diversity and numbers), the manager would probably need to identify a target in order to avoid problems with future certification inspections.

This condition will probably make NCSU cautious about future monitoring efforts. It appears that Condition 18 resulted from a decision to monitor birds and snags. This decision may have been made for reasons that were unrelated to strategic forest management. The certification process may have forced these two monitoring efforts into the management plan. This suggests that any type of monitoring can become part of the management plan via certification inspections. In fact criterion 4.8.4, on which this condition is based, can be interpreted to say that all monitoring efforts must be incorporated into the management plan. This appears to be a questionable criterion for use on university forests because these forests are likely to be involved with research-related monitoring efforts which should not be forced into a management plan. If this criterion were applied strictly, it could also affect the willingness of private forest landowners to become involved with university research.

Condition 20: Within three years of the issuance of a certificate, NCSU's College Forests shall develop and implement a formal monitoring system for ensuring the maintenance of high conservation value attributes and ensure that it is described in management plans and procedures. This effort should include a plan for educating stakeholders on HCVFs. (Criterion 4.9.4)

This condition addresses a formal annual monitoring procedure for ensuring the maintenance of high conservation value attributes. It appears that the procedure has been informal and, perhaps, intermittent in the past. There is a one-time cost to develop the procedure and add it to the management plan. This responsibility will likely fall upon the forest manager. There may be an incremental cost associated with the formality of the procedure, which will probably result in slightly more paperwork than the previous informal procedure. This is likely to be carried out by support personnel. Apparently, areas classified as reserves were visited on a monthly basis in the past. An opportunity may exist to visit slightly less often to offset the additional costs of formalizing the procedure. It is unclear whether this condition calls for the identification of all high

conservation value attributes on the forest or whether it simply calls for renaming selected areas which are presently called reserves. If this condition requires identification and monitoring of all high conservation value attributes, both the one time cost and recurring cost will be significant and there could be a significant opportunity cost if other areas of the forest are taken out of production. Stakeholder education could be accomplished at minimal cost through presentations at annual stakeholder meetings. This would involve a one-time cost associated with an initial presentation and recurring costs associated with updating the presentations.

Because there is not a commonly agreed upon definition of HCVFs, a definition, or a set of high conservation value attribute identification criteria, must first be established for the college forest. An approach that is consistent with current management would involve the identification of a set of attributes that are common to the areas currently in the HCV category so that these areas become the basis for the definition of HCVs on the college forest. Once the attributes are identified, they (and the HCV areas) can be protected. Although the condition specifies maintenance of these attributes, the certification document also substitutes the word “protection” for maintenance.

The following information has been extracted from the certification report. It may help put this condition into perspective.

“The FSC has organized a technical committee to assist FSC-approved certifiers in developing procedures for more consistent application of the HCVF idea. FSC regional standards groups are wrestling with this issue as well. In addition, SmartWood has already implemented certification assessments in a number of HCV forest areas. The main implications so far have been that:

- 1. Technical environmental, forest and social assessments must occur to determine HCVF presence; and,*
- 2. Stakeholder consultation procedures need to be particularly strong in areas where HCVF may exist.*

In the absence of absolute clarity in regards to either (1) or (2) above, SmartWood has taken an extremely proactive approach to stakeholder consultation and, in particular, application of the following criteria and indicators, and section 6.0 on Environmental Impacts. SmartWood headquarters staff should be consulted in any and all circumstances, whether there are either procedural or technical questions. Scale issues are particularly important; no one expects small landowners to be able to cover HCVF issues as well as larger organizations, but conservation of HCVF values must be stressed in all cases. “

“Most respondents in the stakeholder survey had never heard of a HCVF (59%). While there were some comments on the confusing definition of a HCVF in the FSC P&C most (71%) felt that forests should be considered for HCVF status if they meet the criteria set forth. Twelve percent of respondents did not offer an opinion on this last item.”

This condition and criterion appear to be in a state of development, and SmartWood has requested contact when questions arise (*“SmartWood headquarters staff should be consulted in any and all circumstances, whether there are either procedural or technical questions”*). Therefore, a strategy that involves asking questions that require specific answers (e.g. yes or no) may be of value to NCSU.

Summary of estimated costs and time requirements of all 23 conditions

Table 1 summarizes the types and estimated magnitudes of the costs of complying with the conditions of certification. Complying with some of the conditions may also result in various types of benefits. The table does not attempt to estimate the benefits.

Table 1. Summary of types and estimated magnitude of costs and time associated with certification conditions (VL = very low, L = low, M = moderate, H = high)

Condition	One-time cost	Recurring cost	Opportunity cost	Recurring time (Mgr.)	Recurring time (other)
1	L	L	L	L	VL
2	L	M	L	M	L
3	L	VL	VL	VL	VL
4	M	H		M	H
5	L	L		L	L
6	M	M		L	L
7	H	L		L	
8	M	L-M	L-M	VL	L-M
9	L-M	L-M	L-H	L-M	VL
10	L			VL	
11	H	L	M-H	L	L
12	L	L		VL	
13	L			L	VL
14	H	L	M	L	L
15		L		L	L
16	L	VL			VL
17	VL				
18	L	L	L	VL	
19	L	VL			VL
20 *	M-H	L-?			L
21	L	L			L
22	L				
23 **	M	L		L	

* Costs will be higher if identification of all HCV attributes is undertaken and an opportunity cost could occur.

** Additional costs or benefits may occur

GIS-based analysis of condition 11 involving BMPs

Condition 11: Within one year of the issuance of a certificate, NCSU's College Forests shall develop guidelines that describe those factors that indicate exceeding BMPs may be required. (Criterion 4.6.5)

According to the criterion, BMPs are being exceeded in some cases. Part of this condition involves documenting the rationale for current cases in which BMPs are exceeded. Part of the condition addresses missed opportunities to establish SMZs exceeding BMPs. This condition could result in high one-time costs associated with developing the guidelines and identifying the new stream segments (i.e. the missed opportunities) that must comply with the guidelines and now must exceed the BMPs. Much of this work will likely be done by the forest manager. In addition, the cost of identifying and mapping intermittent streams is a moderate one-time cost involving students and technicians. Although it could be argued that this cost should be considered part of the cost of building a GIS database, these data have been collected directly as a result of certification. There will likely be a low recurring cost associated with complying with and enforcing these guidelines. Establishing SMZs that exceed BMPs will result in an opportunity cost in terms of lost timber revenue. This opportunity cost is based on the extent to which BMPs are exceeded and has the potential to be significant, particularly if intermittent streams are considered.

The fact that the criterion addresses "missed opportunities to establish SMZs exceeding BMPs" is worth considering. It raises a question about whether this condition could lead to an unwritten, more stringent set of BMPs. This could result in the forest manager spending time defending the use of BMPs on the school forests when the certifying agency wants the BMPs exceeded. It could also result in NCSU conducting an analysis of the effectiveness of BMPs in maintaining water quality on the forest.

This section of the paper presents the results of an analysis of the effect of stream buffers of 50, 75 and 100 feet on blocks A and C of the Hill Forest. Both perennial and intermittent streams are analyzed subject to limitations in the data set. Perennial stream data were available in the original data set. Intermittent (and possibly ephemeral) stream data were available from GPS files created specifically for the Hill forest (this category will be referred to as intermittent streams for the purposes of brevity). The results should underestimate the effect for intermittent streams because some of these data were questionable and were not used in the analysis. It is likely that there are more intermittent streams on the forest than were available for analysis. Some of the intermittent stream data coincided with perennial streams. In addition, one perennial stream was added at the request of the forest manager. This analysis is confined to blocks A and C primarily because of the lack of quality intermittent stream data and some questions about the perennial stream data on the remainder of the forest.

The analysis was done twice using different assumptions about the streams. First, the streams were buffered at 50, 75 and 100 feet from the probable center of the stream. This was done for the perennial streams and for the intermittent streams. These files were then combined for each buffer width. This resulted in three files for each buffer width (perennial, intermittent, and combined). The perennial and the combined files were used in the analysis. The intermittent files were not analyzed alone because some of the intermittent stream data coincided with perennial stream data. Separate analysis would result in duplication of some of the results. The perennial stream data were assumed to be more accurate than the intermittent stream data.

Buffering from the center of the streams is not accurate if the streams are wide. Therefore, the analysis was done a second time under the assumption that the Flat River was 50 feet wide and all other perennial streams were 12 feet wide. Intermittent streams were still buffered from the center. The results of this analysis are presented here.

Blocks A and C contain three land use categories: O – operational; S – special use; and R – reserved and unproductive. One would expect much of the land affected by the buffers to be in the R category, because this category was likely created, in part, to protect streams. This is what the analysis showed. The total areas affected by buffers of various widths are shown in Table 2.

Table 2. Area affected by different buffer widths (stream widths considered)

Land Use	Total acres in Blocks A & C	Area in acres affected by each of the following buffer widths in feet					
		50 perennial	50 combined	75 perennial	75 combined	100 perennial	100 combined
blank	2.41						
S	16.65	0.14	0.40	0.60	0.95	1.23	1.62
R	174.21	24.90	48.79	35.90	65.92	46.64	81.31
O	454.34	5.81	25.28	8.69	37.30	11.75	49.97
Column sum	647.61	30.85	74.47	45.19	104.16	59.63	132.90

Table 3 shows the percentages of the total land use categories occupied by each cell of Table 2. The 50 foot perennial buffer affects only 4.76% of the land in blocks A and C. Adding intermittent streams increases the effect to 11.50%. The greatest effect occurs with the 100 foot buffer and intermittent streams. This affects about 20% of all land in blocks A and C. In all cases, most of the land affected by the buffers is in land use category R (Table 2) and the highest percentage of land affected by the buffers is also in land use category R (Table 3). Thus, it appears that the land classification system has served its purpose well. Buffers affected from 1.28% to 11.00% of land classified as operational.

Table 3. Percent of land in each land use category affected by specified buffer widths (stream widths considered)

	Percent of total area in land use class that is affected by each of the following buffer widths					
Land Use	50 perennial	50 combined	75 perennial	75 combined	100 perennial	100 combined
S	0.87	2.40	3.62	5.69	7.41	9.75
R	14.29	28.00	20.60	37.84	26.77	46.67
O	1.28	5.56	1.91	8.21	2.59	11.00
All land in A and C	4.76	11.50	6.98	16.08	9.21	20.52

Buffers can have a serious effect on the operability of an area. The 50 foot buffer is the standard for the types of streams found on blocks A and C, and the forest managers have been adhering to BMP standards with regard to perennial streams. Therefore, the 50 foot buffer affects mostly reserved lands with very little effect on operational lands. Widening the buffer increases the effects on reserved lands and operational lands.

However, the greatest impact on operational lands occurs when the intermittent streams are included. This is because allowance has not been made in the past for some of these streams and several are situated primarily on operational lands (assuming the GPS data files are accurate).

The following effects can occur when buffers fall on operational lands. The buffer might occupy an entire stand, thus changing the land use category for the entire stand. The buffer might occupy a large proportion of a stand or it might split a stand into several pieces such that the remaining operational segments are too small or fragmented to manage effectively. For example, in one case, a .08 acre sliver of an operational stand remained after a buffer was applied. In the short term, harvests will likely be reduced on these segments with the segments being re-delineated and combined with adjacent stands over time.

Of course, the most significant effect on operability is that as much as 11% of operational lands can be affected by a 100 foot buffer on perennial and intermittent streams. If these lands are converted to the reserved land use category, a considerable amount of income will be lost. If it is possible to switch some excess reserved lands to the operational category, the loss of operational lands can be offset and the loss of income can be minimized.

Certification condition 11 addressed the development of guidelines that “describe those factors that indicate exceeding BMPs may be required”. Tables 2 and 3 suggest that BMPs are currently being exceeded in most instances in the case of perennial streams. If the reserve land use category qualifies as a SMZ, increasing the buffer widths on perennial streams simply increases the amount of land taken from the reserve category with very little effect on the operational category. A 50 foot buffer overlaps 5.81 acres (1.21%) of operational land. Increasing the buffer to 75 feet increases the amount of operational land overlap by less than 3 acres to 8.69 acres (1.91%) total. Increasing the buffer to 100 feet results in another increase of about 3 acres to 11.75 acres (2.59%) total. However, each increase in buffer width results in only about an additional 3 acre overlap with operational areas. Figure 1 illustrates this argument. It is a stand map of Blocks A and C of the Hill Forest with 100’ perennial stream buffers and non-operational area overlays. Non-operational lands surround almost all of the perennial streams and extend beyond the 100’ buffers in most cases. Thus, buffers on most of these streams can be expanded further without greatly impacting operational areas. The rightmost stream is the one added for the analysis. It is entirely on operational lands and it looks like it may be too far to the right. In fact, this segment accounts for 4.3 acres of operational lands (of 11.75 total – Table 2). If this stream segment actually goes through the non-operational area to its left, the segment would affect slightly more than 1.89 acres of operational lands (because the non-operational area occupies 2.41 acres). The effect of 100 foot buffers on operational areas can be seen more clearly in Figure 2. The affected operational areas consist of two segments and small fragments near a bend in a stream. Much of the affected land is accounted for by the stream segment discussed above.

Figure 1. Perennial streams with 100' buffers

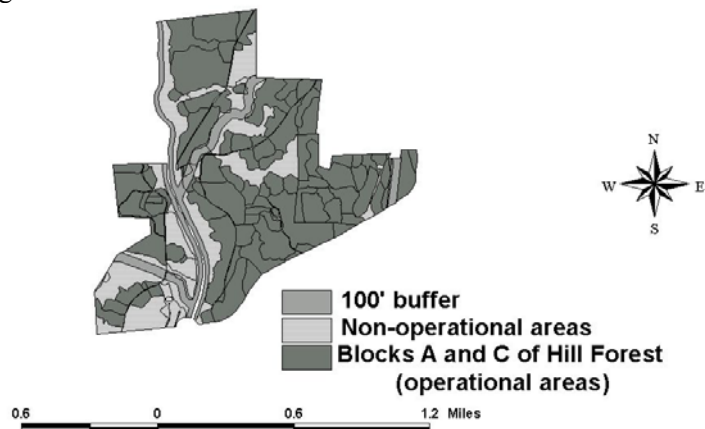
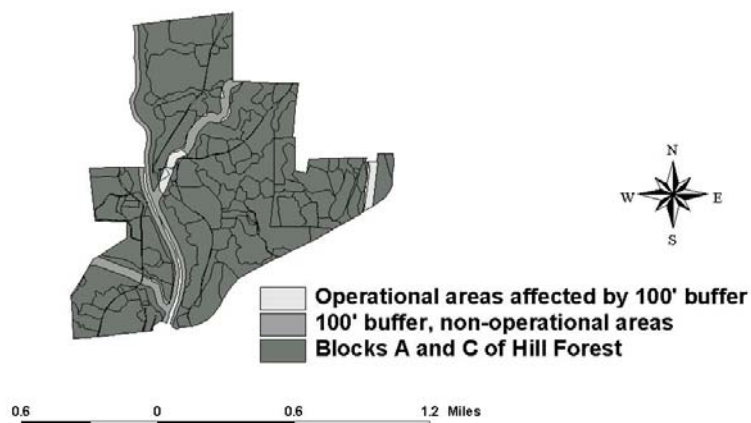


Figure 2. Operational areas affected by perennial streams with 100' buffers



CONCLUSIONS

Many of the certification conditions have relatively little impact on cost or management of the forests. Others will require large costs and/or have a large impact on management of the forests. Almost all of the conditions require some of the forest manager's time and more than half require additional time by other personnel. The long-term effect of compliance may require an additional employee. Some conditions are broad and leave room for interpretation. The magnitude of impacts and costs for ambiguous conditions will depend on the manager's and certifier's interpretation of the requirements. Analysis of buffer strips on parts of the school forests indicates that NC State is currently exceeding BMP requirements for perennial streams and that small increases in buffer width would affect mainly reserved (non-operational) land.

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An Evaluation of Forest Property Tax Programs in the United States

Julie Rodenberg, Michael Jacobson, and Mark McDill

Abstract: Tax treatment of forest land can impact forest management practices and influence landowner decisions to maintain land as forest or convert it to other uses. State and local tax laws can provide incentives for forest conservation and reduce economic pressure for conversion of forest lands. Each state has a unique approach to taxing forest land and some states are considering revising their legislation on forest property taxation.

Property tax programs change periodically, and a current description of each program is essential to understanding forest property tax systems in the United States. A matrix of current systems allows for an easy comparison of programs. Our matrix details the type of property tax, laws and objectives, program requirements, penalties, and administrative responsibilities for the thirty-seven states outside the South. The matrix is detailed enough to provide a good understanding of current state property tax systems and the format allows for easy comparison between different state systems. State forest property tax alternatives include (a) exemptions and rebates, (b) harvest taxes, (c) modified property taxes including flat taxes or productivity (current use) taxes. The forest property tax matrix is useful to landowners, policy-makers, business leaders and forestry professionals.

Southern Forest Sustainability and Local Government: Cases in Perverse Incentives

Michael Mortimer¹ and Dylan Jenkins²

America is a nation blessed with extensive forest resources. However, navigating the paved pathways of America's urban jungles, the public is generally unaware that they are often surrounded by a forested landscape. To illustrate this fact consider that in the 13 southern state region, forests cover an average of 61 percent of the landbase per state. An even lesser-known fact is the ownership pattern of America's forests: nationwide, over 10 million private forest landowners (PFL) control 58 percent of America's forestland, 5 million of whom control nearly 80 percent of the southern forest land base.³

Focusing on the southern forest, home to half of America's private forest landowners, we will examine the incentives - both positive and perverse - local governments employ to affect private forest management. Our thesis is simple and is succinctly stated by the Pacific Forest Trust in their recent book *America's Private Forests*: that "...private forests will be preserved only if they remain productive, and can continue to produce only if they are preserved."⁴ To the degree that local governments have attempted to use regulatory authority to positively affect forest sustainability, they have generally failed. The authors' home state of Virginia is used to illustrate the impact of local governing authority on sustaining forested landscapes. Virginia is an excellent case study given the environmental policy climate, its rate of urban sprawl and increasingly fragmented forest landbase, and proliferation of local zoning and taxation policies targeting the use of private forests.

Ranging in individual parcels from 1 to over 10,000 acres, America's private forests collectively form an enormous social asset providing wood and non-timber forest products, filtering air pollution, protecting soil and water resources, supplying fish and wildlife habitat, and creating outdoor recreation and ecotourism opportunities. Often unrecognized by the public and politicians for the role forests play in mitigating air and water pollution, the historic Chesapeake Bay Agreement explicitly recognized the essential contribution of riparian forests toward meeting reduced nutrient and sediment loads into the Chesapeake Bay.⁵ A recent report indicated that of the 23 possible sources of stream impairment, silviculture was one of the least worrisome--contributing to only 5.05 miles of stream, or 0.1 % of the 4282 miles of impaired streams identified within the

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³ Thomas W. Birch, *Private Forest Landowners of the United States, 1994*, USDA FOREST SERVICE, NE FOREST EXPERIMENT STATION, RESOURCE BULLETIN NE-134 (1996).

⁴ Constance Best and Laurie A. Wayburn, *America's Private Forests: Status and Stewardship*, ISLAND PRESS (2001).

⁵ Virginia Governor Gilmore's 1996 Executive Order 48.

Commonwealth of Virginia.¹ Additionally, and of no small note, industries relying on Virginia's private and public forests employ nearly 250,000 individuals throughout all regions of the Commonwealth and contribute over 30 billion dollars annually to Virginia's economy.² Finally, a forest's ability to contribute both predictable water quantity and quality is well established. While some municipal water supplies are protected by publicly owned watersheds, many are not; instead relying upon a landscape mosaic of privately held forestland. Myriad perverse incentives now threaten the integrity of this private forest landscape and the many associated social amenities provided by private forests.

Virginia's forested lands are a significant component of the vast private forests covering much of the Southeast. However, while gaining ground for much of the 20th century, these vast private forests are now succumbing to the pressures of urban and suburban sprawl. Commonly known as forest fragmentation, the effects of urban and suburban development are manifested most visibly at the rural/urban interface in the thousands of acres of large forested tracts (i.e., greater than 100 acres) that are annually parceled into numerous fragmented forests. Forest tracts smaller than 100 acres now represent 25 percent of Virginia's private forest land and this percentage is quickly growing.³ Urban and suburban development was recently identified as the leading threat to existing forested land in the Southeast.⁴ Major southern growth areas, including northern and eastern Virginia, were specifically identified as highly susceptible to losses in forest cover.⁵ Due to their smaller size and frequent conversion to non-forest use, many fragmented tracts lose both their economic and ecological forest values. Tracts that do retain forest use values are often transferred to individuals with little or no knowledge of sustainable forest management practices.

Increasing forest fragmentation and pressures to convert these fragmented forests to non-forest use present significant policy problems for Virginia's local governments. Faced with balancing economic growth and maintaining functioning forest ecosystems, various jurisdictions have turned to regulatory mechanisms to attempt to stem the conversion of forests at the urban/rural fringe. While comprehensive statewide forest regulations have not been enacted in the Southeast, local governments have nonetheless been quite active in the promulgation of forestry-related ordinances. The number of ordinances south-wide have more than doubled in the last eight years, with Virginia tracking that trend closely, increasing from 44 in 1992 to 77 in 2000.⁶ Virginia currently has the second highest number of local forest ordinances in the South. While beginning to recognize forests for more than their aesthetic value, even the most benign local governments lack the competence or inclination to seek the expertise needed to develop ordinances that balance the ecologic and economic roles of southern forests while rewarding investments in private forest stewardship.

¹ VIRGINIA DEP'T OF ENVIRONMENTAL QUALITY, 2002 WATER QUALITY ASSESSMENT AND IMPAIRED WATERS REPORT (2002).

² VIRGINIA DEP'T OF FORESTRY, VIRGINIA'S FORESTS: OUR COMMONWEALTH (2002).

³ Thomas W. Birch, S. Hodge, and M. Thompson, *Characterizing Virginia's Private Forest Owners and Their Forest Lands*, USDA FOREST SERVICE, NE RESEARCH STATION, RESEARCH PAPER NE-707 1 (1998).

⁴ David N. Wear and John G. Greis (eds), *Southern Forest Resource Assessment*, U.S. FOREST SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, TECHNICAL REPORT GTR SRS-53 (2002).

⁵ *Id.* at SOCIO-3.

⁶ *Id.*

Typical of these local ordinances are restrictions on timber harvesting practices. Those restrictions can include requiring pre-harvest plans subject to local approval, restrictions on the use of clearcutting, or requirements for unharvested buffer zones. While some of these regulations are designed to prevent environmental harms such as ensuring water quality, many others are pointed at preserving forest cover. Virginia is a Dillon's Rule state,¹ and therefore restricts the regulatory activities of local governments, however in practice any Dillon's Rule limitations on local forest regulation have been largely lost within the morass of local planning and zoning authority.

This upsurge in the number and type of local regulations has not gone unnoticed at the state level. Quite often the primary reason a state enacts a forest practices act is in response to local regulation. For example, nine of the thirteen southern states have enacted statutes protecting the right of its citizens to practice farming and forestry, attempting to ensure that local regulations could only be effective under very narrow circumstances. Virginia was among the states that passed such a statute. Enacted in 1997,² Virginia's Right to Practice Forestry Law prohibited local government from requiring timber harvesting permits, or prohibiting or unreasonably limiting silvicultural activities.³ This law, however, used as the basis for a challenge to York County's local forestry ordinance, was determined by the Virginia Supreme Court in 2000 (Dail v. York County)⁴ to be largely ineffective in preempting local governments from promulgating such ordinances.

The fallout from the Dail case is that the pattern of local forest ordinance development in Virginia is increasingly haphazard and arbitrary, reflecting little connection to the science of forestry, and even less consideration for the perverse results spawned. As currently designed and implemented, local forest regulations in Virginia are both ecologically and economically irresponsible.

The difficulty with not considering fully the effects of excessive or inappropriate regulation is that such regulations can actually lead to precisely the opposite result intended - a decrease in forest cover, all the while flirting with constitutionally protected property rights.⁵ Regulations increase the costs of forest management, in many cases the burden falling on the smaller landowners with less resources at their disposal. Long-term investment in working forests becomes less attractive as the regulatory environment becomes less predictable.⁶ The statutory uncertainty left in the wake of the Dail decision compounds the problem as local governments continue to dabble in private forest management. All these factors combine to decrease incentives for investment or retention of forested lands in the face of development pressure.

What local governments face, as a result of the nature of their own regulations, can in fact be more development, less forest cover, and greater challenges to water quality than might have existed in the continued presence of managed forests. Even the

¹ See Jesse Richardson, Jr. *Sprawl in Virginia: Is Dillon the Villain?*, VIRGINIA ISSUES AND ANSWERS (2000).

² SB 592 (Va. 1997).

³ VIRGINIA CODE ANN. §10.1-1126.1 (2001).

⁴ Dail v. York County, 259 Va. 577, 528 S.E.2d 447 (2000).

⁵ Michael J. Mortimer, Harry Haney, Jr., and Jonathan J. Spink, *When Worlds Collide: Science and Policy at Odds in the Regulation of Virginia's Private Forests*. JOURNAL OF NATURAL RESOURCES AND ENVIRONMENTAL LAW (2002). (In press).

⁶ Nels Hanson, "Family-Owned Forests in an Era of Regulatory Uncertainty." Paper presented at the Symposium on Nonindustrial Private Forests: Learning From the Past, Prospects for the Future, Washington, D.C., February 18-20, 1996.

tax advantages historically afforded forest landowners have begun to erode, in places where they should be emphasized most.¹

There are at least two recommendations that bear scrutiny. The first echoes the Society of American Forester's position that any forestry regulations should endeavor to create a predictable and relatively stable management environment.² Virginia's current situation is a distant throw from that laudable goal. The failings in "Virginia's Right to Practice Forestry" law identified by the Supreme Court in Dail should form the basis for statutory amendments at the next available opportunity. The zealous approach of local governments to regulating forest land and forest practices should warrant the renewed attention of the General Assembly. This is not a rallying cry for greater state-level regulation to replace the existing patchwork of local regulations. To the contrary, Virginia's existing state-wide forest regulations have largely succeeded in balancing economic growth with forest stewardship and sustainability. Rather, what is called for is the restoration of the purposes and goals of the 1997 legislation, in terms that will satisfy or correct the problems identified by the Virginia Supreme Court.

Additionally, we must recognize that it is not solely the government's responsibility to protect landowners and the public from perceived or actual harms from forest management. Common-law remedies for actual harms caused to other property owners by one's own actions have been available for hundreds of years, and still offer reliable, efficient alternatives to increased regulation.³ Accordingly, private forest landowners bear a certain responsibility for adopting a stewardship ethic, both in crafting mechanisms for sustaining private forest practice and for on-the-ground adoption of scientific and sustainable forest practices. Actual results have varied. For example, only five percent of Virginia's landowners have a written management plan for their property. Management planning is a critical first step in landowners' understanding of the value of their resources and strategy for protecting their land's ecologic and economic assets. While an imperfect measure, management planning is often used as a proxy for the adoption of sustainable forest management practices and as an indication of the percentage of landowners who may be implementing best management practices (BMP's) and sustainable forestry practices. Management planning though, comes at a cost—one that suggests a second recommendation.

The second recommendation proposes a thoughtful approach to providing incentives for private forest landowners to maintain their properties in forest cover. Taxation is of course one highly effective means of doing so, and one used to some extent in Virginia. The inquiry should not end there, however. In this time of budget deficits and declining tax revenues the idea of tax incentives may seem counterintuitive, but the management and maintenance of forest land must be considered in the long term—over the course of decades and generations, not fiscal years.

If indeed the citizens of Virginia are all beneficiaries of the Commonwealths' private forests, it is crucial that the problems identified in the Southern Forest Resource Assessment be addressed in a timely fashion. In creating thoughtful mechanisms to

¹ *Id.*

² Society of American Foresters Position Statement *Public Regulation of Private Forests*. See also, Virginia Society of American Foresters Private Property position statement at <http://www.safnet.org/policy/psst/vapriateprop.htm>.

³ Roger E. Meiners and Andrew Morriss, eds., *THE COMMON LAW AND THE ENVIRONMENT* (2002); Bruce Yandle, *COMMON SENSE AND COMMON LAW FOR THE ENVIRONMENT* (1997).

protect active forest management on private forest lands, the track record of some local governments is less than inspiring.

For example, at the time this article was written, Botetourt County was considering an ordinance that would restrict timber harvesting above 1,500 feet elevation. Interest in creating this ordinance stems from increasing ridgetop development of this bedroom community near Roanoke. While the ordinance was designed to mitigate the aesthetic impacts of forestry and housing development along ridgelines, the ordinance would also restrict other land uses such as agriculture or the nursery/fruit industry. Such is the result of localities designing ordinances that affect rural land use and industry – these ordinances too often have unintended and negative spillover effects, impacting other land uses in their wake. The net effect is the erosion of options and creation of disincentives for viable rural economic development.

Flying in the face of a rational approach to maintaining forest cover, Gloucester County has enacted a program to tax not only the timberland use value, but also the added value of the standing timber. This program is undeniably arbitrary, assessing standing timber values without objective standards, instead relying upon only cursory knowledge of timber valuation. Landowner objectives, while in nearly all cases unknown to the county, are presumed by the county to be commercial in nature. To the contrary, surveys of forest landowner objectives have consistently demonstrated that indeed timber is not the exclusive or even primary landowner goal. Further, timber is not an annual crop, and harvests generally take 30 to 80 years or more depending upon the species. Most costs associated with growing stands of timber are incurred in the early years of the rotation.¹ These costs must be carried through the length of the rotation and are not recouped until when and if trees are harvested to generate revenue for the landowner. Gloucester County's timber tax program is equivalent to taxing farmers on their corn or tobacco crops, except that for forest landowners (many of whom are also farmers) this tax burden is amortized over 30 or more years. Gloucester County forest land owners consequently now face use value taxation, including the added value of the timber annually, as well as a timber severance tax due at harvesting. This is a far cry from a simple yield tax, arguably the best mechanism to encourage long-term investment in forestland.²

In rural Grayson County, landowners are currently struggling with their own Board of Supervisors (BOS) to create a countywide agriculture-forestal district program. Having little industry in this rural economy, and denying land use taxation to farmers and forest landowners, Grayson County has attracted the attention of urbanites from North Carolina's piedmont triad region seeking rural retreats in this picturesque landscape. The tax base relies on the taxation of land and rural land values now approach \$10,000 per acre. Given the lack of industry in Grayson County, the Grayson BOS must address the creation of agricultural-forestal districts that may arguably decrease tax revenues. Regardless of the eventual resolution, a comprehensive plan that would implement a creative approach to the rate and placement of housing development, the Grayson BOS will still be faced with the unenviable task of maintaining a rural landscape and economy and generating tax revenue on a land base that is unattractive to industry while highly sought after for large-tract housing development.

¹ A rotation is the time period (usually in years) between establishment of a stand of trees and the cutting of those trees.

² Lawrence S. Davis and K. Norman Johnson, *FOREST MANAGEMENT* (1987).

The City of Bluefield has recently rejected a zoning variance request to harvest timber on 80 acres of private land within the city limits. The City's decision, admittedly on residentially zoned property, ensures that the parcel will remain subject to development deforestation pressures, while simultaneously precluding economic forestry uses and continued forest cover.

Even the Chesapeake Bay Local Assistance Board has recently promulgated regulations that will prevent landowners of less than 20 acres of forest land from taking advantage of the forestry exemptions to the Chesapeake Bay Preservation Act regulations- particularly when the average forest land ownership is only 29 acres.¹ The exemptions will remain, however, for large landowners. The Board's failure to recognize the forestry implications of such a regulation may indeed stem from the absence of a professional forester on the Board.

Virginia is by no means alone in facing the problems illustrated here. Many of the southern states are facing increases in the number of local regulations (Figure 1), many to the point where "without successful amelioration measures it will become impractical to practice forest management in increasingly large areas of the South."²

State	1992	2000
Alabama	0	6
Arkansas	3	6
Florida	26	46
Georgia	41	116
Kentucky	0	0
Louisiana	25	52
Mississippi	1	7
North Carolina	1	16
Oklahoma	0	0
South Carolina	0	9
Tennessee	0	0
Texas	0	11
Virginia	44	77
Total	141	346

Figure 1. Local forest-related ordinances in the southern states.

Source: USDA, SFRA 2002.

The problem is not limited merely to increases in local regulations. While use value taxation, an historic strategy for preserving forest land, is available in all thirteen southern states, it is mandatory in only three (Figure 2). Furthermore, while its effectiveness as a means for preventing conversion to other uses is questionable, the elimination or the corruption of use value taxation only encourages the pace of land use conversion. Specifically, while several states statutorily prohibit the taxation of standing

¹ Birch et al., *supra* note 4.

² USDA SFRA

timber, others do not (Figure 2). The taxation of standing timber in addition to taxation of the bare land (and its potential for timber production) largely defeats the original purpose of the use value forestry tax incentive. Annual ad valorem taxation of standing timber will inevitably drive investment away from forests and into alternative land uses. These regulatory and taxation policies at the local level are conspiring to accelerate the loss of Southern forest cover.

State	Optional/Mandatory	Taxation of Standing Timber
Alabama	Optional	Prohibited
Arkansas	Mandatory	
Florida	Optional	
Georgia	Optional	Prohibited
Kentucky	Optional	
Louisiana	Optional	
Mississippi	Mandatory	Prohibited
North Carolina	Optional	Prohibited
Oklahoma	Mandatory	Prohibited
South Carolina	Optional	
Tennessee	Optional	
Texas	Optional	Bare Land Only
Virginia	Optional	

Figure #2. Use Value Taxation in the southern states. Source: USDA SFRA (2002).

In seeking to maintain a rural landscape, many counties default to their ability to simply regulate land use. However, other counties have adopted a more proactive collaborative community planning approach. This approach acknowledges the full array of tools available to citizens and planners to conserve land uses. Broadly defined, these tools include incentives (such as use value taxation and agricultural-forestal districts) and investments (such as fee simple land purchases and easement acquisition). Used in conjunction with regulatory and zoning authority, localities can design a creative approach to land use conservation that acknowledges and cultivates the private economic contributions to private forest landowners in addition to the public amenities provided from private forests.

According to Leesburg Virginia community planning consultant Milt Herd, the Virginia counties of Albemarle, Augusta, Fauquier, Loudoun, and Montgomery are at the forefront of adopting and experimenting with the full range of land use conservation tools available under Virginia legislative authority.¹ In addition to the tools already discussed, i.e., land use taxation, agricultural-forestal districts, and zoning regulations, these counties have either adopted or are in the process of catalyzing active land use via private and public investments. Two such examples are rural economic development initiatives and purchase of development right (PDR) programs.

¹ Milton Herd. Task 3 Report: Review and Evaluation of Land Conservation Tools; Montgomery County, Virginia Comprehensive Plan Update 2002; draft – September 3, 2002. Herd Planning and Design, Ltd. 112pp.

Rather than exporting raw farm and forest commodities from a locality to be processed into final products, rural economic development initiatives promote economic activity in rural areas by helping communities add value to natural resource-based commodities close to home. In the process, local jobs are created and the active land uses on which those jobs depend, i.e., agriculture and forestry, compete in the land market against “higher and better uses” such as urban and suburban development. Undeniably, most rural economic development programs have focused on promoting independent family-run agricultural enterprises, taking the form of farm tours, farmers markets, market guides, agri- and ecotourism development, and producer cooperatives. One notable exception is the Northwest Pennsylvania Industrial Resource Center (NWIRC) that focuses on promoting local value-added forest products industry in rural northern Pennsylvania. By adopting a “business clusters” approach, NWIRC has helped create communication and marketing linkages between private forest landowners and local wood products companies.¹ Successful rural economic development programs are characterized by multi-agency cooperation and buy-in from key players such local government, Resource Conservation and Development Councils, cooperative extension, chambers of commerce, and of course, private landowners.

Following the relatively recent growth of the land trust community using conservation easements as their primary land conservation tool, purchase of development (PDR) programs are likewise gaining increased popularity with local governments to conserve rural landscapes.² PDR programs are essentially publicly sponsored land trusts that employ conservation easements to protect rural landscapes. Development rights are expensive commodities especially in rapidly urbanizing rural landscapes. Consequently, because these programs rely heavily on taxes to purchase development rights, PDR initiatives have historically been used by rapidly growing and well-healed communities that can afford to implement the program, examples include: Sonoma County California, Boulder Colorado, Southampton New York, and Virginia Beach Virginia. Regardless of whether or not an easement program is publicly or privately funded, easements must be crafted to allow the land to generate revenue from active agricultural and forestry practice while protecting the land resource.³ This is easier said than done and much attention has been recently paid to promoting active land use, i.e., protecting the right to farm and forest rural lands, versus eroding both development and management rights.⁴

Like the regulatory authority of local government, catalyst programs have their strengths and challenges and must be judiciously applied in the appropriate context to protect active forest land use. However, the common strength of all investment-type programs is arguably the recognition that market-based tools play a critical, and often more effective role than regulation in conserving rural forested landscapes. As the ultimate authority for guiding land use development and conservation in any locality, local governments should thoughtfully incorporate all available and appropriate catalyst and control tools in their comprehensive plan.

¹ Fred D. Baldwin, *Business Clusters: Building on Local Strengths*, APPLALACHIA, September-December pp. 2-9 (2001).

² C. Timothy Lindstrom, *State Tax Incentives for Conservation Easements Can Benefit Everyone*, JOURNAL OF MULTISTATE TAXATION AND INCENTIVES, pp. 21-48 November/December 2002.

³ Steven Bick and Harry L. Haney, *The Landowners Guide to Conservation Easements*, KENDALL/HUNT (2001).

⁴ Brenda Lind, *Working Forest Conservation Easements*, LAND TRUST ALLIANCE EASEMENT SERIES, 2001.

A final and often overlooked rural land conservation investment tool is landowner education. Education is a critical mechanism for empowering those who own and manage the majority of the Commonwealth's land base. While viewed as suspect by the activist environmental agenda as inferior to regulation, forest landowner education is a critical component in helping landowners understand the numerous values of the forest and enabling them to adopt best management practices on their woodlands. Since 1996, slow but steady momentum has been building behind Virginia's Forest Landowner Education Program (VFLEP). Since 1997, over 73 short courses have been offered in all regions of the state to inform landowners of their options to conserve and protect forest and agricultural land. Based on participant surveys, estimated potential economic impact from these programs is \$15 million ranging over 330,000 acres. This sum represents additional income generated (or costs saved) by implementing voluntary land use conservation practices on private forestlands.

Landowners are often surprised at the range of options available for land use conservation, including the opportunity to develop income from timber and myriad non-timber resources on their property. These resources include recreation and hunting leases, non-timber forest products such as greenery, medicinal and edible plants, fee-fishing enterprises, and agri-tourism and eco-tourism opportunities.

In addition, training programs such as the Virginia Certified Planning Commissioner's Program encourages citizens, including forest landowners, to become actively involved in shaping the form of land use policy in their communities. The service of forest landowners on their local planning commissions, board of zoning appeals, and agricultural-forestal advisory boards is an important mechanism to integrate the views and values of rural landowners in the creation of economic development initiatives and, when necessary, land use regulations in their locality¹. Because foresters and forest landowners naturally think in terms of decades when planning for land uses, they have a competitive advantage in guiding the land use planning process. In the past two years, the authors have documented numerous success stories of forester and forest landowner activity in guiding reasonable local land use policy.

Nevertheless, while market-based tools and incentives exist for creative land use planning and conservation, the fact remains that few localities adopt a comprehensive community planning approach. In addition, the larger question of who has authority over the management of Virginia's private forests looms over the best-informed local land use planning bodies and creates an instable regulatory vacuum that will be filled. Interest groups favoring regulatory approaches have recognized this vacuum and are now placing their supporters, model forest practice ordinances in-hand, on local land-use advisory committees, such as planning commissions, and boards of zoning appeals and supervisors. Further, regulatory uncertainty in southern forests has not gone unnoticed by the forest industry. Many major forest products companies have divested of their American forestland holdings, in part, to replace them with forests in nations with less costly forest regulations.² The drain of markets for privately owned forest wood and fiber is already being felt throughout the South and will exacerbate the lack of investment

¹ Dylan H. Jenkins and Dan L. Goerlich, *Foresters and the Local Land Use Planning Process*, JOURNAL OF FORESTRY (2003) (In press).

² Roger A. Sedjo, *Local Communities, Global Perspectives: The Spatial Scale of Forest Policy Implications* in FOREST POLICY: READY FOR RENAISSANCE, 1998 p. 205-216; Bruce Lippke and Chadwick D. Oliver, *Managing for Multiple Values*, 91 JOURNAL OF FORESTRY 14 (1993).

in private forest management. Again, lack of investments in private forest management will further the liquidation of private woodlands and subsequent increased conversion to development and non-forest use. Vastly differing interest groups can make for strange bedfellows, but their different policies with regard to private forest stewardship should have the same goal -- incentives in private forest investment and prevention of the liquidation of forest lands.

SUMMARY

Southern forests are predominantly owned and managed by nearly 5 million private forest landowners. Collectively these landowners provide many of the benefits that society demands at little or no cost to the general public. In fact, private forest landowners largely (unwittingly) subsidize society's demand for environmental benefits by absorbing the many costs associated with forest ownership. Local and state governments should recognize the positive externalities provided by private forest landowners by crafting market incentives and, when necessary, ordinances that promote and reward (rather than erode) active forest management on private forest lands. Further, the unresolved and patchwork nature of regulations, particularly at the local level must be addressed. While some local governments are progressively working with foresters and forest landowners to develop sensible market-based approaches to forest stewardship, many are heading in the opposite direction. The trend is disturbing in light of the fact that South-wide, forests alone represented nearly half of the land converted to development from 1992-1997.¹

The goal of any local government in designing a comprehensive land use conservation strategy should be just that – comprehensive and in consideration of all available tools. With respect to the conservation of farmland, no locality would consider a farmland conservation plan that does not include farmers or farming. The same is true for forestland. For forests to remain a viable part of the landscape, forestland must compete in a free-market economy with alternative land uses such as housing development. Hence, forests require forestry -- active management -- for the generation of income opportunities for those who own and live on the land. Given the myriad public benefits provided by private forests, the goal of any locality in protecting their green infrastructure should be to ensure that options for active forest management are not only maintained, but also encouraged.

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Supra, note 5 at SOCIO-8.

Land Trust Activity and Property Tax Assessment in Georgia

Columbia L. Mecham and David H. Newman¹

Abstract: Land trusts work at the grassroots level to conserve land and natural and cultural resources. Their activities may be influenced by financial considerations, including property taxes. Questions regarding the perceptions of land trust activity by local government officials and the subsequent property tax assessments of protected land have gone unexplored, due in part to a lack of comprehensive statewide information on individual conserved properties. We present selected data from a statewide census of land trusts to illustrate the extent and characteristics of private land protection activities in Georgia. We then present the results of a qualitative study of county tax assessors regarding their experiences with and treatment of privately protected land. The results show that over the last ten years, land trust activity has grown rapidly in the state, bringing changes in the nature of land protected. With the growth of land trust activity and the development of differential taxation programs for the protection of farm and forestry land, county tax assessors must now measure the public benefit provided by land protection and balance it with the traditional objective of conducting equitable and uniform assessments.

Key Words: Conservation easement, Qualitative research, County government

INTRODUCTION

Land trusts are local, regional, national, and international organizations that aim to protect land and/or natural, cultural, or historic resources through education, property rights acquisition, and cooperation with the government. By the year 2000, there were over 1,200 land trusts nationwide and approximately 38 in Georgia (Land Trust Alliance 2001; Georgia Land Trust Service Center 2002).

Land protected by land trusts either through conservation easements or fee simple ownership must be assessed for property tax purposes. Georgia law entitles the grantor of a conservation easement to a “revaluation of the encumbered real property so as to reflect the existence of the encumbrance on the next succeeding tax digest of the county” (O.C.G.A. § 44-10-1), and exempts “all institutions of purely public charity” from property taxes (O.C.G.A. § 48-5-41). Property taxes can be manipulated to encourage land conservation, such as through differential taxation programs. In that same vein, property tax policies developed for the assessment of land protected by land trusts can have the effect of either encouraging or discouraging land trust activity.

The accurate assessment of easement-burdened properties for property tax purposes faces several obstacles. First, market data are lacking for sales of easement-burdened properties, making traditional valuation methods obsolete. Second, variations in the assessment of such properties are often attributed to varying attitudes among county tax officials (Diehl and Barrett 1988, pp.56-57; Stockford 1990; Ceglowski 1992; Closser 1994). These attitudes may be negative or positive with respect to conservation

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easements or land protection in general. Local approaches to the assessment of conservation land held fee simple by land trusts may also vary based on local attitudes.

Property tax assessment of privately conserved land is an issue for landowners and land trusts wishing to participate in private land conservation. A survey of easement donors found that while property tax was not a major motivational factor for landowners who donate conservation easements, it was the issue that caused the most dissatisfaction among the donors (Elconin and Luzadis 1997). The state has also identified problems with the reassessment of easement-burdened properties as a major hindrance to the use of conservation easements in the implementation of the Greenspace Program (Georgia Community Greenspace Program 2002).

Land trusts have a particular interest in the property tax assessment of fee simple conservation land. In a survey, land trusts ranked the ongoing cost of ownership, with property taxes noted in particular, as one of the four most important obstacles to the use of fee simple acquisition (Burkhard 1994).

From the existing literature, it appears that a lack of market data and varying attitudes among county tax officials are the major factors influencing current property tax assessments for privately protected land. While the lack of data upon which to base assessments is a widespread problem that will only be solved over time, local attitudes towards land trust activity can be addressed now, if they are understood. At this point, however, local government perspectives on land trust activity have not been studied.

The objectives of this research were, first, to determine the current use of conservation easements and fee simple acquisition as land conservation tools among land trusts in Georgia, and second, to develop a framework in which to better understand local government approaches to private land protection within the context of property tax assessments.

METHODS

Land Trust Survey. Using a list of Georgia land trusts maintained by the Georgia Land Trust Service Center, we mailed surveys in April 2002 to all the land trusts on the list for a total of 38 survey recipients. Non-respondents first received a follow-up postcard and then received one or more telephone calls and a second mailing of the survey, based on survey methods described by Dillman (2000).

The surveys were designed to determine the current use of fee simple ownership and conservation easements as land conservation tools among land trusts operating in Georgia. They asked for information on every property that each land trust held fee simple or that was encumbered by a conservation easement. Although some of the survey recipients operate in other states besides Georgia, the survey only asked for information on their properties in Georgia. The survey was not sent to government entities that could be holders of conservation easements.

Qualitative Study. We used the grounded theory approach as the basis for the qualitative data collection and analysis (Glaser and Strauss 1967; Rubin and Rubin 1995; Strauss and Corbin 1998). The primary data-collection tool was an open-ended interview with county tax officials, usually the chief appraiser. A total of 14 interviews were held with county tax officials. We selected county tax officials for interviews based on a number of factors. Due to the perceived importance of geographic location, rural or urban character, and land trust activity in influencing a county tax official's view of private land conservation activity, we selected counties individually based on these factors to represent a wide diversity of counties and regions.

Interviews were also conducted with the executive directors of two land trusts, three conservation easement donors, one official from the Department of Revenue, and one county land use planner for a total of 21 interviews over a non-consecutive 3-month period in 2002. In-person interviews lasted from 20 minutes to 103 minutes, averaging 51 minutes. One interview was held over the phone and, due to time constraints felt by the interviewee, lasted only 11 minutes. All interviews were recorded on audiotape with consent from the interviewee and transcribed. Once all transcriptions were complete, we had approximately 180 pages of transcribed interview data with which to conduct a grounded theory analysis.

Due to the public nature of the county tax official's position, all quotes presented in the results are uncited. We promised confidentiality to all interviewees in order to allow them to speak freely without concern of criticism from the public or the governments they serve, or from their fellow appraisers.

RESULTS AND DISCUSSION

Land trust survey. We received responses from 92 percent of the survey recipients. Twenty-five (68 percent) of the land trusts that responded currently protect land through fee simple ownership or conservation easement. The current state of private land conservation in Georgia is summarized in Table 1.

Table 1: The use of conservation easements and fee simple acquisition by land trusts in Georgia in 2002

<i>Tool</i>	Number of land trusts using tool	Number of counties with protected land (out of 159)	Number of acres	Number of parcels
Conservation easement	23	42	45,352	141
Fee simple acquisition	13	34	19,358	84
<i>Total</i>	25	57	64,710	225

As seen in the Table 1, almost every active land trust in the state uses the conservation easement as a conservation tool, and about half use fee simple ownership. Just over one-third of the counties in the state have land trust activity.

Private land conservation through the use of conservation easements and fee simple acquisition has grown rapidly in the past decade. Figure 1 shows the rise in the number of parcels in fee simple and conservation easement held by land trusts in Georgia. While fee simple acquisition was the first tool used by land trusts for land protection in Georgia, the use of conservation easements eventually surpassed it. By 2002, conservation easements comprised 63 percent of the total number of parcels of conservation lands and 70 percent of the total acreage of conservation lands.

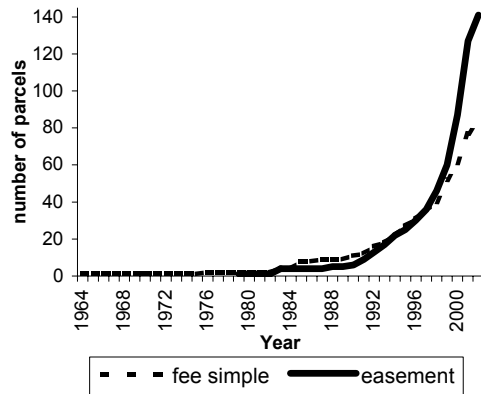


Figure 1: Cumulative number of parcels held fee simple and in conservation easement by land trusts in Georgia, 1964-2002

As land conservation through fee simple ownership and conservation easements has increased over the past 40 years, the nature of the parcels has changed in some respects. Figure 2 shows the change in average parcel size over time. While the average size of fee simple parcels has remained about the same, the average size of conservation easement parcels has decreased by approximately 75 percent since its highest point in 1991.

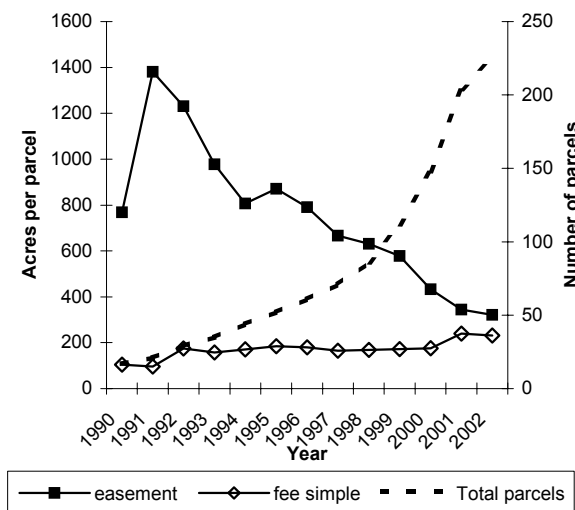


Figure 2: Average parcel size of properties held fee simple and in conservation easement by land trusts in Georgia, 1990-2002

There are clear patterns in the distribution of land trust activity around the state. Figure 3 shows that North Georgia has the majority of parcels protected by land trusts, but these parcels are, on average, smaller. South Georgia has the vast majority of the acreage protected by land trusts spread among relatively few large tracts.

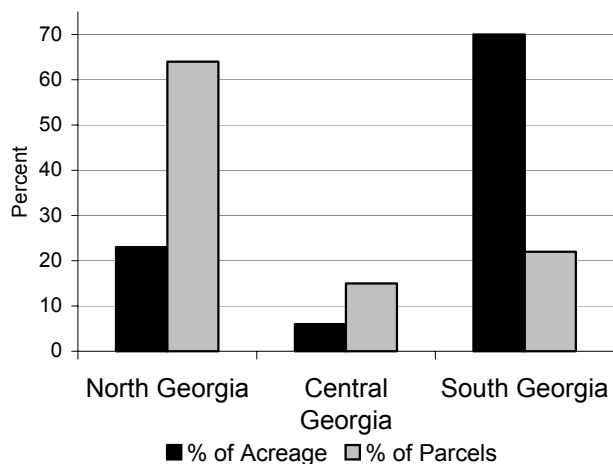


Figure 3: Distribution of land trust activity in Georgia

To conclude the land trust survey results, we found that land trusts in Georgia had protected about 65,000 acres by the year 2002. This is approximately the same amount of land that is within the Georgia state parks system.

Some of the survey findings have significance for property taxes. In particular, the greatest proportion of parcels protected by land trusts is in North Georgia, where property taxes are more significant due to higher land values. Also, the increasing popularity of conservation easements has implications for property taxes because partial interests are more difficult to assess for property value. The next section will explore the issue of property taxes in more detail.

Qualitative study. From the analysis of our interview data, we developed the grounded theory that the county administration of property taxes for privately conserved lands¹ is influenced by an effort to measure the public benefit provided by land protection and balance it with the traditional objective of conducting equitable and uniform assessments. This grounded theory is built upon a number of related themes. The themes presented here include the consideration among tax assessors of 1) equitable and uniform treatment; 2) state versus local authority; and 3) the perceived conservation value of private land protection.

Equitable and uniform treatment. County tax assessors are interested in achieving equitable and uniform assessments both within their counties and across counties. As one tax assessor explained, “Every year when we send out all the assessment notices..., people’s biggest fear is this: am I in the same boat as my neighbors? Are we all being treated the same together? If you can pretty much demonstrate that, you’re okay.” However, tax assessors may experience difficulty in achieving such goals, given certain

¹ In the context of the interviews, the programs and tools for land protection that were discussed included the Conservation Use Program (Georgia’s differential taxation program for farm and forestry land), conservation easements, and fee simple conservation land.

state policies and laws. Tax assessors used the Conservation Use law as an example: “Right now there are 159 different counties, so I’d probably estimate that there are 159 ways [the Conservation Use Program is] being done. And that’s a problem, that’s really a problem.”

State versus local authority. Considerations of state versus local authority are important in understanding the way that local tax officials approach the assessment of privately protected land. Often associated with issues around state versus local authority is the clarity of state law. One tax assessor described a situation in which a land trust had applied for an exemption for their fee simple property. The tax assessor denied the exemption, and the land trust appealed the denial with the county’s board of equalization. He went on to explain, “The [land trust] took it to the Board of Equalization, which we didn’t really object to; we thought they were doing a good thing, but we just didn’t have the authority [to exempt it].” In this instance, the local tax officials were interested in promoting the private land protection by providing an exemption, but did not feel that the state had given them the clear authority to do so. Instead, they felt it necessary to follow the longer appeals process.

A second concept that arises with issues of state versus local authority is local governments’ perception of burdens imposed by state laws. Conflict may arise between state interests in, for example, greenspace protection, and the resulting impact on the tax base at the county level. The argument has been made that counties end up carrying the financial burden for benefits enjoyed by all residents through the state-sanctioned exemption of certain properties (Siegel 1997). As a result, counties may end up resenting state mandates for exemptions.

While some tax assessors did express this general concern in our interviews, we found that, at least with respect to special assessments for the promotion of land protection, most tax assessors did not resent state-mandated exemptions or reductions in assessments. As one tax assessor explained, “We’re here to do a job, and that job is to enforce the laws of the state. Now of the state comes out with some kind of laws that we should exempt these things and develops some criteria for that, that’s fine.” This quote is especially illustrative because it came from a tax assessor in a county with a particularly high exempt digest; he was especially conservative about exempting properties.

The question then arises, “Why would some tax assessors view special assessments for land protection at least somewhat favorably?” This leads to the third theme to be discussed, the perceived conservation value of private land protection.

The perceived conservation value of private land protection. As was stated in the grounded theory at the start of this discussion, given new tools and programs for land protection in Georgia, tax assessors are finding themselves attempting to measure the public benefit provided by private land protection. One basis for this measurement is the concept behind cost-of-community-services studies (CCSS). CCSS’s show the impacts of various levels of development on county revenues from property taxes. One tax assessor explained it this way:

You can’t just think about [land protection] in terms of, ‘how much money are we losing on the tax digest?’ Because really, if that were developed into...minimal cost and minimal value houses, then its really costing the county money, because they’re not paying enough in taxes to offset what it costs to fund those houses and pave those roads and so on.

From the interviews, we found that tax assessors in general are highly cognizant of the concept behind CCSS's, and apply it in their work.

Finally, there are less concrete ways in which tax assessors may go about measuring the public benefit provided by private land protection. The last two quotes provided here, each from a different tax assessor, serve as examples of the various perceptions that tax assessors may hold towards private land protection, and that may influence their assessments.

1) [These easement-burdened properties provide] a big benefit...capital letter B big. Beautiful land..., great scenic value..., the amount of wildlife you see is incredible.... And talk about other environmental benefits, we have very clean air; we have some of the cleanest water in the state of Georgia.

2) Well then when you ask them if its open to the public, 'oh, well no, they've got to get permission to go on it.' Well that's not open to the public. If this is going to be for public benefit, purely charitable benefit, there shouldn't be a loop you've got to jump through to get there.

Later in the interview, this tax assessor went on to say, "Somebody has got to bring [a policy] together, and get something that's sound, that will pass a lot of tests. And nobody's done that."

The conclusion that we draw from the qualitative analysis is that the efficiency of rewarding credible private land protection through property tax reassessments is hindered by a lack of clarity and guidance in state law and policy. To address this problem, we are recommending state policy revisions and adoptions that would provide greater uniformity in the property tax assessment of privately protected lands.

ACKNOWLEDGEMENTS: We would like to acknowledge the Georgia Research Alliance Traditional Industry Program for Pulp and Paper (TIP-3) for funding this research, and Hans Neuhauser and Marilyn Ostercamp of the Georgia Land Trust Service Center for working with us to conduct the land trust survey. We would also like to thank the individuals that agreed to participate in the interviews.

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An Evaluation of Georgia's Conservation Use Valuation Assessment Program

David Newman, Dawn Black, and Coleman Dangerfield¹

Abstract: The 10th anniversary of implementation of the Conservation Use Valuation Assessment (CUVA) in Georgia occurred in 2002. This milestone prompted us to initiate an evaluation of the program through a user response survey. The program has been extremely well-received by landowners with more than 60,000 covenants representing greater than 5 million acres enrolled in the program. This level of interest notwithstanding, there has never been an assessment of users' satisfaction with the program. Our study's primary aim was to determine covenant holders' overall satisfaction with the CUVA, including future expectations, and land management decisions initiated since their enrollment. Covenant holder information was obtained from 26 county tax assessor's offices and a total of 1320 surveys were mailed to a stratified random sample of covenant holders throughout the state. A response rate of 61% was attained with a usable response rate of 54%. From this data, the clearest finding is that covenant holders are generally quite happy to receive this tax-reduction and that it is a program they like. Respondents did list a number of concerns about the program's administration but most focused on difficulties in entering the program, rather than its usefulness.

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A Comparative Analysis of Industrial Timberland Property Taxation in the U.S. South

Guiping Yin and David Newman¹,

Abstract: We present a comparison of fair market values (FMVs) and the subsequent property tax burden of industrial timberland conducted for five southern States – Alabama, Georgia, Mississippi, North Carolina, and South Carolina. Variations between states were substantial, as major differences exist in taxation methods. The results showed that Georgia’s industrial timberland maintains the highest fair market value and incurred the highest property tax burden. Only Georgia assesses industrial timberland at FMV, while the other states use some form of current use assessment. When we include additional taxes, Georgia is still substantially higher than the other states in the study. Thus, Georgia is put into a relatively disadvantageous competitive position because FMVs can be substantially higher than current use values, especially in areas with high development pressure. In addition, since Georgia industrial timberland holders are unable to take advantage of other tax relief programs, which are made available to private forest landholders; they are further hampered within their own state. In regression analysis of factors influencing assessments, the best predictors of fair market value included location, population growth rate, and participation in Conservation Use Valuation Assessment program.

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Female Forestland Owners: Characterization of Assistance Needs

Sarah Day Crim¹, Mark Dubois, Conner Bailey, and John Schelhas²

Abstract: There is a limited amount of research focusing on female forestland owners. In looking at female forestland owners as a group researchers are often left with more questions than answers. What is the role of these landowners in the forestry sector? How do female forestland owners manage their lands? Do female forestland owners possess unique characteristics, needs, and interests? From the limited research available, it appears that female forestland owners do express some similarities; they are older, own small amounts of acreage, and have a more pronounced interest in ecological management (Warren 2003, Lidestav and Ekstrom 2000). This paper characterizes female forestland owners in their land management practices and their accessibility to knowledge dealing with their land. The data consists of information received from 39 semi-structured personal interviews with female forestland owners in rural Alabama

INTRODUCTION

Non-industrial private forestland owners form the base of our nation's timber supply. Non-industrial private forestland owners (NIPF) own more than 60 percent of the timberland in the United States (Bourke and Luloff 1994) and this percentage continues to increase (Birch 1997). Timberland accounts for 71% of the total land area in Alabama (Hartsell and Brown 2002) equaling 22.9 million acres. The majority of this timberland base is in the hands of non-industrial private landowners (NIPF), accounting for 78% (18 million acres) of the total ownership of Alabama (Hartsell and Brown 2002).

The subject of NIPF landowners has been widely researched, in part because of the impact they play in maintaining and sustaining forests. There is a wealth of information available dealing with the landowner's roles, decision-making processes, and overall management and involvement with their forestland. However, there is a limited amount of research that has been conducted on characteristics of female forestland owners.

This topic is of relevance to policy makers because of recent public disclosures that the U.S. Department of Agriculture in the past has discriminated against minority farmers in a manner which contributed to black land loss (United States Department of Agriculture 2001). The USDA Forest Service wants to examine the question of service provision to forest land owners. In this paper, the focus is on female forestland owners in Alabama, specifically motivations, experiences, and the education.

This study was conducted in two regions of Alabama, the Black Belt and the Piedmont. Both of these regions are heavily forested but differ in how these resources are used and in their demographic profiles. Alabama is a prime location for a study such as this because of its significant contribution to forestry. Alabama is home to over 1,100 forest manufacturing operations, has 70,000 citizens directly employed in forest related occupations, and timber the dominant crop harvested in 34 of Alabama's 67 counties

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(Alabama Forestry Commission 2002). The heart of this enterprise is the timberland base in Alabama.

Three major objectives were covered in this study:

- 1) Review the status of female forestland ownership in Alabama including the extent to which these populations are underserved by public agencies that support the forestry sector.
- 2) Characterize the relationships between female forestland owners and their land holdings; including management objectives, timber production, and current resource uses.
- 3) Identify the major sources of programs related to forestry issues used by female landowners.

LITERATURE REVIEW

Women Forestland Owners. Compared to the literature on women's roles in agriculture and farming (Effland et al. 1993, Haney and Knowles 1988), there have been relatively few studies looking at women as forestland owners. There has been some research on this topic from Sweden which concluded that the average size of women's land holdings was significantly lower than men's (Lidestav & Ekstrom 2000). The authors noted that in the U.S. the same trend exists, that on average, women's holdings constitute one-third the acreage of men (Lidestav and Ekstrom 2000).

This study also revealed some notable differences in the forestry practices between males and females. They found that there are fewer timber sales among female owners and harvesting activity was found to be less frequent on female land holdings. Females were also more inclined to regenerate their timber (Lidestav and Ekstrom 2000). Several of these differences can be linked to external factors including ownership size, site quality of the land, and age of the landowner. However, at the conclusion of the research, it was determined that some of their results could not be attributed to the above confounding variables but were only explained through the analysis of gender (Lidestav and Ekstrom 2000).

Women Forestland Owners in Alabama. In a recent survey by the Alabama Forestry Association (2003), trends affecting female forestland owners were examined. The study was done using a random sample of 300 forestland owners, of which 30 percent were women.

A high percentage of women, 42 percent, indicated that they felt the first role for forests in Alabama was to provide wildlife habitat. This was compared to the 26 percent of men who indicated the same sentiment (Kennedy and Roche 2003). This data confirms past studies (Lidestav and Ekstrom 2000, Warren 2003) that show that women tend to place other values on forests besides timber production. When asked the primary use of their forestland, 33 percent indicated recreational (including wildlife related activities), while 40 percent said it was to raise and harvest timber.

The percentage of women harvesting timber was lower than the percentage of men, 75 percent compared to 82 percent. The management practices of both males and females from this survey appear to be fairly consistent, although they express different attitudes toward the role of forests.

The Kennedy and Roche study also addressed the educational needs of the landowners. There were differences between the interests of males and females. Thirty-seven percent of the women landowners felt that wildlife conservation was the most important educational topic provided by landowner agencies, with 24 percent interested in learning more about Best Management Practices, and 15 percent about marketing timber. However, the males felt that marketing timber was the most important educational topic, 28 percent, with 24 percent interested in wildlife conservation and 20 percent in Best Management Practices (Kennedy and Roche 2003). This difference again demonstrates the interest of women in forest values other than timber. This information can be used in future educational opportunities by resource agencies to best meet the needs of female forestland owners.

The existing literature does not address whether women landowners are underserved in the field of forestry. Do they receive the same benefits from land ownership as men? Are they aware of programs which are available to provide either financial aid or educational help?

METHODS

The methods used for this study were primarily qualitative rather than quantitative. A qualitative approach best fit the overall objectives of the study by providing a framework for exploratory research, given that there are limited data available on African-American and women forestland owners. This study seeks to address this gap by using qualitative methods to answer the questions of why, what, how, and who pertaining to the underserved. The purpose of qualitative methods is to “describe and explain processes and relationships” (Bliss and Martin 1989: 604). Within this framework, hypotheses are developed rather than tested. Qualitative research may provide the foundation for future quantitative efforts by clarifying central questions that need to be addressed.

Snowball sampling was used to locate respondents for interviews. This sampling method starts with a base of potential informant names and branches to include any recommendations given by the informants. The names of potential forestland owners who fit the objectives of the study were collected from the County Extension Agent, the United States Forest Service County Forester, the Natural Resources Conservation Service director, the Alabama Forestry Commission Minority Outreach Forester, local forestry consultants, and several other key informants.

Interview questions were written and pre-tested before being taken to the field. The survey consists of 30 questions fitting into four categories: ownership history, management, assistance, and demographics. Interviews were conducted both over the phone and face-to-face. When possible, the interview was conducted at the landowner’s home, but in the case of absentee landowners this was often not possible. Interviews were also conducted over the telephone in accordance with the landowner’s preference.

RESULTS

Forest Landowner Demographics

The demographic characteristics of this study confirm the existing literature on female forestland owners (Warren 2003). The average age of these individuals is above 60, and most are retired from the workplace. The land distribution for female forestland owners follows the general pattern of distribution for the counties studied, but on average the amount of acreage owned was below the average. Thirty-nine female forestland

owners were interviewed, 29 white and 10 African-American. Twenty-seven of the landowners lived in the same county as their land while the other 12 were classified as absentee landowners from surrounding towns or distant cities.

Ownership History

There are strong ties that bind female forestland owners to their land. In the case of land inheritance, these ties are associated with the past owner of the land, often the male head of the family. These feelings are especially strong amongst the widowed women who express a desire to 'keep things the way that he did.'

There is a general assumption that many women forestland owners receive their land from inheritance (Warren 2003), either through a deceased spouse or close family member. Though the data from this study confirms this view (72 percent inherited all or part of their land), this does not mean they are passive in their land management style. Female respondents, who inherited their land, exhibited a strong drive to protect and to manage the land in a 'right' way.

In several interviews, women would tell how their family had been in the region for at least a hundred years, many tracing their history to the cotton plantation days. A woman described how her land originated with her great-great-grandfather when he homesteaded some of the land back in the 1830's. The land used to be used as mainly a family farm with mostly cotton and corn crops, until someone in the family let the land grow over and it became seeded with timber. Many of the older women have this same deep connection with the land that traces back to their birth. The land that they currently own is the land that they grew up on, it is the land that they have always known and thus holds a unique and special place in their life. Although most of the younger landowners do not share this same depth of experience, the same sentiment of preserving family history often is expressed. 'Amy,' a landowner from Randolph County, recently inherited a piece of her land that she shares in ownership with her cousins she said the land was purchased in 1928 and has been passed down through the family since then. She said that her parents used to live on the land but that she did not ever visit it until only recently. She said that her primary interest is to build the land back up and put a home on it so that the family will always have a place to stay whenever they want to return to Alabama.

There was a strong tendency for the women to refer to their land as being inherited from the male patriarch in the family. The female respondents spoke of their land inheritance as coming from their 'grandfather' or 'father' rather than their mother or grandmother. In fact, twelve of the seventeen linked their inherited land to patrilineal sources, two linked it to the matrilineal and the other three linked it to the general term 'family' or 'heir.' These references to family were usually followed by a story or a memory connecting the past to the present. A woman lovingly told how her land was originally cotton plantation farmed by her father and then after her father grew older it was leased to another farmer for production. Once in her possession, they decided to plant it in pine trees. She has kept this part of the property because her father once had a lot of property but he lost a lot of it during the depression. This was one of the pieces that he kept and he used to take her out on it and tell her that she would go to college off the trees that she saw.

The link between the male head of the family and the land is one that may correspond to the landowner's memories on the land. Those who associate the land with the patrilineal tell of times with their father or other male figure just as those who associate the land with the matrilineal share memories about their mother. One woman

talked a lot about her mother and the memories that they shared in the old homeplace. 'Eloise' who had just turned 90 years old recalled that, "Back when her mother owned it, they grew sorghum, sweet cane, potatoes, peas, cotton, corn, and rice. They also had chickens, cattle, and turkeys." In her home she had a picture of her mom, probably in her 90's, feeding the chickens; it was a full circle of ownership. Thus, there appears to be a link between the persona dominating the memories associated with the land and the persona identified as the giver of the inheritance of the land.

Though their name is on the deed, it seemed that some of the women thought of the land as belonging more to the person that they inherited it from. A respondent described how she inherited the land after her uncle passed away. She said that he was a sharp man and took every opportunity that he had to invest in the land, and that she has been trying to do the same.

To these women, land is a part of their heritage, a memory of a past loved one, and they feel that it is their job to maintain the integrity of that heritage. Maintaining this heritage means not only keeping the land deed in the family, but also upholding the past practices of the land. They express a duty to uphold the practices of the owner before, to "try and do the same."

This sentiment is felt strongly within the widowed landowners as well. Ten of the respondents are widows, all but one of whom received their land through inheritance of their deceased spouse. Among these women, the purpose of 'family tradition' was more prevalent as a response to primary interest on the land. Those who were widows overwhelmingly wished to "keep up the land just like he did." In a recent article, Sarah Warren (2003, 3) sets out to disprove the 'just widows' assumption that is sometimes held by forest managers. She states that it is frequently suggested that 'just widows' inherit wooded land from husbands, but have no idea about forest management. Or, they are more likely to be cheated by unscrupulous timber buyers... 'Just widows' are dependent on others for decision-making and land use planning. 'Just widows' have little impact on the goods and services provided by forested lands. As with all generalizations, these assertions are not always true.

The widows interviewed in this survey tended to break the bounds of the 'just widows' assumptions by carrying on the legacy of their spouse through 'good' land management activities. Their fervent desire to 'keep up the land just like he did' propelled them to make wise decisions about the present and the future of their inheritance.

Management

The management objectives of women forestland owners focused on a balance between timber and conservation. One woman best summed this approach by saying that she was "Tickled with the timber sales but that the land also brought her a warm feeling." Another woman described the same sentiment, "I want the money from my hardwoods, but I don't want to cut them to get money from them." This desire for balance impacts every aspect of the women's land management from planting to harvest.

Timber. Nine of the 39 respondents, 23 percent, had a professionally written management plan. Five of these plans were written by professional forestry consultants, the other four were written by a professional government forester. The women with management plans owned, on the whole, greater amounts of acreage than those without a management plan; of the nine with management plans, six held acreages above the average for the respondents. This is consistent with literature which supports the view

that the greater the acreage, the more intensive the management (Birch 1997). Also, five of the women with management plans had loblolly pine plantations on their land which would seem to indicate an objective of economic returns. However, only two identified economic potential as their primary interest in the land.

Seven respondents had a forestry consultant to help them achieve their management objectives. This characteristic was examined against the factor of acreage and the data showed that three of the women held acreages above the respondent average. When asked about their involvement with forestry consultants, some responded negatively. One respondent said that she had a management plan but was not pleased with it because she felt that it concentrated too much on cutting timber instead of her objectives. She described forestry consultants as "...not concerned with 'balance' in the system."

The primary objective of nine study participants was timber production. There appeared to be a correlation between factors indicative of intensive management and the primary objective of timber production, with five of the nine indicating that they did have a forestry consultant and had pine plantation stands. All of the nine had sold timber off their land. There was no general trend between the objective of timber production and age or acreage. One woman responded that, "My primary interest in the land used to be for timber, but since the prices are so low, I don't have another interest in it except to keep it in the family." This quote may indicate that the interest in timber production is directly dependent on the market prices of production. If the prices are not adequate, then the landowner chooses to use the land for other purposes.

In total, thirty of the 39 respondents (78 percent) had harvested timber from their forests. This percentage is similar to the statewide Kennedy and Roche survey finding at 75 percent. Eleven of these sales were made from a pine plantation, while the remaining were sold from a natural pine/hardwood mix. Fourteen of the landowners re-planted their land in pine plantation, including the two that previously were pine. Additionally, five of the previously natural stands were re-planted in pine plantation after harvest. The high levels of re-planting further support the desire of women landowners to participate in management practices that sustain the life of the forest. There did not appear to be a correlation between timber sales and age or acreage.

Seventeen women had sold timber under a logging contract and bidding process. However, several mentioned having negative experiences with loggers. One female said that the process of selling timber was satisfactory but that the "loggers left a big mess" on her property. Another woman shared the same sentiment that the process was fine but remarking that the land was so ugly when the trees were cut it looked like it had been "raped." Finally, in another case the respondent was highly dissatisfied with the logging that was done. She said that they totally butchered the land and took whatever trees they wanted and added that the dishonesty of logging contracts would be a good thing to write a paper on.

'Sustainability,'¹ of the land was also highly emphasized by respondents in the interviews. When asked the question, "What are your future plans for the land," every answer was directed towards a desire to pass the land along to their descendents. This desire was not just to pass along the deed of the land, but also to conserve the resources that the land provides for the next generation. One respondent indicated she learned does

¹ The actual term 'sustainability' was never used in an interview. However, by drawing upon its definition by the Brundtland Report, "Meeting the needs of the present without compromising the needs of the future," I feel that the attitudes expressed by the landowners were concurrent with the term.

everything she can to make conservation the focus of her land management because she remembers a time when it was not a priority. In addition, two women indicated that conservation was one of their primary interests in the land. They expressed this conservation value by engaging in management practices such as re-planting and following the Best Management Practices guidelines.

Wildlife. None of the respondents indicated that wildlife management was their primary interest in the land; however, many of them described wildlife as a positive aspect of the forestland. Thirty-four of thirty-nine (87 percent) said that they encountered wildlife on their land ranging from game to non-game species. Six landowners (15 percent) leased a part of their land to a hunting club. A landowner in our survey with over 500 acres told that the leases for her property are sold for \$5,500.00 a piece which brings additional income to her on yearly basis. Additionally, a woman praised her involvement with hunting leases. They also manage for wildlife, including plots of pure hardwood trees for acorns. They have a local hunting club of 20 members who use their land almost year round. They said that the hunters on their land will usually keep them updated as to the status of their timber.

The upkeep service that hunters provide is especially helpful for women who are not able to go out on their land on a regular basis. However, the down-side to hunting clubs is that it immediately leaves the landowner open to various liabilities that might occur if an accident were to happen on the land. One respondent said she is not willing to take that risk. She said that they actively manage for wildlife including deer, quail, and turkey for their personal enjoyment and hunting but do not want to lease out any of their land for a hunting club or licenses because of the liability. Another recounted that in the past she has been asked to permit hunting leases on her land, but won't do it because she is a nature-lover and the thought of someone killing a baby deer on her land doesn't sit well with her. With or without hunting leases, a few of the respondents said that they believe hunting takes place on their land without their permission. One woman whose land is near the Talladega National Forest has trouble keeping hunters off of her land because they confuse her property with public domain. Still another woman says that she allows local adolescents to hunt both deer and squirrel on her land because she knows that they would probably be there anyway.

The role of wildlife and wildlife management appears to be important to many of these women landowners. The wildlife gives the owner a personal enjoyment and a means of recreation whether in sightseeing or hunting. In the survey done by the Alabama Forestry Association they found that 42 percent of the women felt that providing wildlife habitat was the first role of Alabama forests. This statistic further supports the views of the women in our survey indicating that wildlife are an integral part of the forest and an issue of concern and importance.

Assistance

Education. Eight of the 39 respondents said that they had attended some type of education program on land management. All of the responses from these programs were positive. Most of the women attending these programs were relatively younger and had land holdings greater than the average. The women also tended to participate in more management activities. The types of programs varied from those offered by county agencies to those offered by forestry groups such as the TREASURE forest organization. The involvement that women have in these programs varied as well. One woman said,

“They go every chance that they can get” while others described going to one or two depending on their interest.

Four of the women, 10 percent, indicated that they were members of the TREASURE forest organization and attended meetings regularly. These women tended to own greater amounts of acreage than those who did not attend the programs. Several of the women, when asked about their involvement in landowner organizations, mentioned that they had an interest in the TREASURE forest county meetings that took place, but had not attended the programs due to scheduling conflicts or lack of adequate and timely information. The organization appears to be the most actively attended landowner organization. The respondents were not members of any other type of landowner organizations such as the Alabama Forest Landowners Association or any type of environmental organization.

In addition to scheduled educational programs and landowner meetings, there appeared to be a network of information that was passed from woman to woman in social circles. This network consisted of social ties through outside groups such as bridge clubs and civic and church organizations. The information spread through this network is selective in both its distribution and depth, however in small rural communities such channels are a major means of communication for many.

Female landowners tend to seek information sources in which they have built trust. Several women indicated that a lot of their education about land management comes from their close family and friends. Absentee landowners especially rely on the help of local relatives to monitor the status of their land and provide any kind of protective measures that may be needed. One woman sought the assistance of her friends when seeking a logger to cut her timber. Another woman received information about local financial opportunities through a cousin that had been involved in the program. Still others are related to professionals in the field of natural resources who offer them advice on management of their timberlands. It is interesting to note that this education received from family/friends is not legitimized through professional status but through trust. The landowner gives value to the voice that has their best interest in mind rather than the voice that might have the best knowledge.

Financial. A total of 16 of the 39 respondents had applied for a financial cost-share program for their land. Twelve of the landowners had received grant monies while the other four had either been turned down or their grant was pending. Most had learned about these programs either through their forestry consultant or local advertising. Those most satisfied with the programs tended to be those that had received funds. One such landowner praised the financial grant process. She said that the program has been marvelously helpful to fill in the gaps between the time of planting her pine plantation and the time of harvest. Another recipient praised the cost-share program she had been involved with saying that it gave her the financial opportunity to re-seed her forest after the land had been cleared in harvest. Through this, she was able to meet her goal of maintaining the forest for the future.

However, in another case a woman was turned down for a grant and the result was detrimental to her land. She said that the resource agency told her that she would receive the grant, but later told her that they could not provide her funding. So, she said after that she hasn't had any interest in re-planting. The impact of obtaining these grants in these two cases changed the dynamics of the forest. In one, success led to the owner's renewed interest in the land, in the other, disappointment led to the owner's disengagement of interest.

The process of applying for a cost-share program can often be problematic. 'Mary,' a younger woman with a Ph.D degree complained that the grant process was confusing and full of discrepancies. "I was amazed at how complicated the programs (FIP, CRP) were and that if I can't understand it how does a person with a high-school education deal with it?" This complicated process leads some landowners to the conclusion that one woman put simply, "I'd rather do it myself than mess with the government."

The financial aid programs available to forestland owners are limited. The NRCS director in one of my counties of study estimated that they received around 30 applicants for the Forestry Incentive Program (FIP). Of these 30 applicants, only four are funded. According to NRCS data, from 1999-2002, ten white females and no black females received FIP cost-share programs from my two counties of study. The average funding covers around 200 acres for site-prep and planting.

CONCLUSIONS

The information collected from interviews with females helps to fill in a gap of knowledge regarding unique characteristics of this group of landowners. The data revealed that female forestland owners have some of the same characteristics as male forestland owners, but that there are points of division where females tend to have a greater interest in the ecological and wildlife value of the forest. The expressed interest in non-timber values of forestland are further pronounced among women who have inherited their land and wish to keep it sustainable for the future generations. Seventeen of the 39 female respondents who had inherited their land listed family tradition as their primary objective in land management. In addition, four of the women who had purchased their land named family tradition as their primary objective. In total, 54 percent of this study's respondents stated that maintaining a family tradition of land ownership was a primary goal. This emphasis on family tradition has not previously been documented in the literature. This, along with other traits, provides depth to the base of knowledge on female forestland owners on which further research can be conducted.

Women with larger acreages tended to be more actively involved in management, specifically for timber. There was a strong anti-logging sentiment from the respondents based on previous bad experiences with loggers and personal beliefs. The women forestland owners generally managed their land with outside help either through a forestry consultant, government agency representatives, or close family and friends. This was especially true with the widowed and absentee landowners. The involvement of women in assistance programs tended to be higher among younger women with larger landholdings. There also appeared to be a greater involvement by women who were involved in other aspects of the community such as local bridge clubs or church and civic organizations. This correlation can be linked to the spread of information through social ties within the community. The overall satisfaction of the women involved with these programs was fairly high. However, the respondents who had not been involved tended to have a negative view of the process of obtaining financial grants, labeling it as biased towards larger landowners.

Further research is needed to examine the characteristics of female forestland owners in different settings, and to relate these characteristics to services (governmental and private) available to forest land owners. The information presented in this study presents only a small picture of what is occurring in underserved land ownership. Female

forestland owners represent only one group of the underserved. Other groups, including minorities and limited-resource landowners also fall under the category of underserved in terms of their access to government landowner resources. There is still little known on these individuals in terms of their motivations and management. Research on service provision to underserved forestland owners are needed identify better methods of reaching and meeting the unique needs of these groups.

In the case of female forestland owners, more service concentrating on non-timber values such as wildlife and conservation appears warranted based on the results of this study. Female respondents involved in this study, have a strong interest in wildlife and conservation values associated with ownership of forests and a desire to learn more about ways in which they can manage their lands accordingly. In addition, information transfer should occur through pathways of trust. It is through these encounters that female forestland owners are most likely to gain knowledge.

ACKNOWLEDGEMENT: This project is part of a larger project sponsored by the Alabama Consortium on Forestry Education and Research. Thanks to the USDA Forest Service Southeastern Research Station for providing the funding for this project. Additional support was provided by the U.S. Department of Agriculture through the National Research Initiative Competitive Grants Program. The views in this paper are strictly that of the authors' and do not necessarily reflect the views of the USDA Forest Service or Auburn University.

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Determinants of landowner participation in the Safe Harbor Program

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Note: This paper is being considered for publication in a journal. In order to avoid potential copyright conflicts, we have decided not to publish the complete paper in these proceedings. Please contact the primary author for additional information on this study.

Abstract: This paper presents an empirical analysis of the determinants of landowner participation in the Safe Harbor program. Safe Harbor has been introduced as an alternative to the traditional ‘command and control’ approach of implementing the Endangered Species Act. Results from the empirical model suggest that parcel size, ‘risky’ land characteristics such as being near known Red-cockaded Woodpecker (RCW) and having mature pine on land, some silvicultural management practices such as burning, landowner perceptions and opinions about Safe Harbor and Endangered Species Act, and landowner’s source of information about Safe Harbor are the significant determinants of participation in the program. The results will be useful to public agencies and policy makers in refining the program strategies and increase the rate of participation.

Key Words: Endangered Species Act, Safe Harbor program, binomial logit model.

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**Community Choices and Housing Decisions:
A Spatial Analysis of the Southern Appalachian Highlands**

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Abstract: This paper examines land development using an integrated approach that combines residential decisions about choices of community in the Southern Appalachian region with the application of the GIS (Geographical Information System). The empirical model infers a distinctive heterogeneity in the characteristics of community choices. The results also indicate that socioeconomic motives strongly affect urban housing decisions while environmental amenities affect those of rural housing.

Key Words: community choices, housing decisions, spatial econometrics.

INTRODUCTION

Land development has drawn increasingly more attention in the last few decades, partly because of changes in land use patterns. For example, the amount of urban land per person is increasing faster than the population: one-third more land per person was consumed by urban uses in 1990 than in 1970 (Daniels and Bowers 1997). Residential development, driven by residential preferences within the constraints of land use regulations, is the dominant force in overall development. Understanding residential choices is the key to understanding much about land development.

In the standard model of a monocentric city (e.g., Alonso 1964; Mills 1981; Muth 1969), residential development is modeled as the choice of location that provides the best tradeoff between land costs and transportation costs. The standard model has been extended in a number of ways, including consideration of urban growth dynamics (e.g., Fujita 1982; Anas 1978), environmental amenities (e.g., Wu 2001; Brueckner, Thisse, and Zenou 1999; Polinsky and Shavell 1976), and multiple income groups and employment centers (e.g., McMillen and McDonald 1989). Recent empirical analyses of this type have been improved through the incorporation of spatial statistics with the Geographical Information System (GIS) (e.g., Ding 2001; Lake, Day, and Lovett 2000; Geoghegan, Weinger, and Bockstael 1997). GIS and spatial statistics allow for spatially explicit analysis by providing flexibility in specifying models and measuring variables.

Economic models of land use have been applied to both broad units and fine units, based on the spatial scale of land use. Models of broad units examine patterns of land use from a macro viewpoint. These models generally use counties or county groupings as units to highlight how socioeconomic factors and physical landscape features influence land use allocations (Alig 1986; Hardie and Parks 1997; Miller and Plantinga 1999; Plantinga 1996; and Hardie, et al. 2000).

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Models of fine units, on the other hand, provide analyses of spatially explicit land use decisions. These models estimate the direct influence of site-specific factors because they are applied at a fine resolution. For example, the road construction and access influences on land development (e.g., Chomitz and Gray 1996; Nelson and Hellerstein 1997; Dale, O'Neill, and Pedlowski 1993) and the influences of location, topography, and ownership (Turner, Wear, and Flamm 1996; Spies, Ripple, and Bradshaw 1994) are analyzed in this framework.

Even though each type of model independently serves a valuable function, they both have limitations. Macro-scale analyses do not capture information in a spatially explicit framework, while micro-scale analyses may miss out on broader physical and social phenomena. Wear and Bolstad (1998) explain the limits of land use models for different units. They point out that land use models of spatially broad units may not provide direct insights into the fine-scale socio-economic and physical consequences of land-use changes. They also discuss the limitations of fine-scale units, including the resolution of the definition of land use. For example, residential presence in the satellite images of forest cover (e.g., Wear and Flamm 1993; Turner, Wear, and Flamm 1996) may not capture site-specific land uses. One type of model could be complemented by the other type of model, yet there has been no attempt to link models of different scales in the previous literature.

This paper examines land development using an integrated approach that combines residential decisions about choices of community (broad units) with site-specific information regarding development using US Census blocks of the Southern Appalachian region (fine-scale units). We do this with the application of GIS and econometric tools. Residential development plays an increasingly important role in the Southern Appalachian region's land development. Because institutional factors such as land use regulations have only a minor influence on the area's development, the Southern Appalachians provide a less complicated study site for testing our methodology.

The Empirical Model

Residential decisions are modeled in two stages in order to link community choice with a site-specific census block. In the first stage, we model the choice of a community type in broad units. The community types are classified as urban-dominant, urban-moderate, rural-moderate and rural-dominant communities according to the types of housing. A multinomial logit framework is used to examine heterogeneity in the characteristics of different community choices. In the second stage, residential decisions based on site-specific census blocks are modeled using housing density equations. The housing density found in the 1990 U.S. Census at the block level is used to examine site-specific residential decisions. The estimates of the community choice models are then incorporated into the housing density equations as a form of self-selection variable. We do this to check if a self-selection bias arises in the formation of the community-type choice. The spatial variables in the housing density equations, a combination of distance and location attributes, are incorporated through the application of GIS.

The Choice of Community Types

Suppose a household tries to choose a community from among four possible types of communities. The types of communities are based on degree of urbanization. Let u_j^* be the household's expected utility from choosing a type of community j . The community j is indexed as 1, 2, 3 and 4 for urban-dominant, urban-moderate, rural-moderate and rural-dominant communities, respectively:

$$(1) \quad u_j^* = Z' \gamma_j + e_j$$

where Z is a vector of community characteristics influencing the choice of the community and e_j is a residual capturing errors in perception and optimization by the household. The household's utility in choosing an alternative community is not observable, but their choice of a community is. Let J be a polychotomous index denoting the household's type of community.

$$(2) \quad J = j \text{ if and only if} \\ u_j^* = \max(u_1^*, u_2^*, u_3^*, u_4^*).$$

Maddala (1983) shows that if the residuals e_j are independently distributed with an extreme value distribution, then the choice of the type of community can be represented by a multinomial logit model (Maddala 1983, p. 60). Following McFadden (1973), disturbances are assumed to be independent and identically distributed with a Weibull distribution. This implies that the probability of choosing a type of community j by the household can be expressed as

$$(3) \quad P_j \equiv \Pr(J = j) = \frac{\exp(Z' \cdot \gamma_j)}{\sum_{i=1}^J \exp(Z' \cdot \gamma_i)} \\ j = 1, 2, 3, 4.$$

The multinomial logit model is estimated using the urban-dominant community as a base of community choice (see the discussion in the *Estimates of the Community Model*). Previous studies (e.g., Nechyba and Strauss 1998; Rapaport 1997) suggest that individual community choices are specified as a function of household characteristics and community attributes. Here we consider the influence of individual-specific characteristics (the household characteristics of education level and political view) and choice-specific attributes (the community attributes of population density, crime level, stability, and level of air pollution).

In the first stage, the multinomial logit model in equation (3) is estimated. We also estimate the marginal effects of explanatory variables on the choice of alternative communities as

$$(4) \quad m_j = \frac{\partial P_j}{\partial Z} = P_j (\gamma_j - \sum_{j=1}^J P_j \gamma_j).$$

These marginal effects depend on the sign and magnitude of many coefficients. The statistical significances of these effects are estimated by the asymptotic covariance matrix of m_j ¹.

¹ A detailed description of marginal effects and their asymptotic covariance of multinomial logit can be found at p. 916-17 in Greene (1997).

Housing Density Equations

The residential decisions are directly reflected by the housing counts of a given area. The housing count per km² of the 1990 U.S. Census block is defined as housing density. The housing market is assumed to be in equilibrium; this requires that households optimize their residential choices. Community choices are assumed to be made prior to residential choices. With these assumptions, the housing density can be described as a function of the socioeconomic and environmental characteristics of the block, in addition to a self-selection variable in the formation of community choice. The following housing density equation is estimated in the second stage.

$$(5) \quad h_{ij} = x' \beta_j - \theta_j \hat{\lambda}_j + e_{ij},$$

$$j = 1, 2, 3, 4$$

where h_{ij} is the housing density of a block i at community j ; x is a vector of socioeconomic variables and environmental variables; $\hat{\lambda}_j$ is a self-selection variable for community j ; and e_{ij} is a residual capturing errors in perception and optimization by the household's choice of a site-specific block and a community. The self-selection variable is estimated using the following equation (Lee 1983).

$$(6) \quad \hat{\lambda}_j \equiv \phi[\Phi^{-1}(\hat{P}_j)] / \hat{P}_j,$$

where $\hat{P}_j = \frac{\exp(Z' \cdot \gamma_j)}{\sum_{i=1}^J \exp(Z' \cdot \gamma_i)}$ from the estimates of the first stage. The form of self-

selection variable incorporates residential decisions about choices of communities into the residential decisions concerning blocks. We consider explanatory variables x to include socioeconomic variables describing housing value, income, population density, crime rate, stability, education, political view, travel time to work, distance to any city, distance to major city, distance to major roads and a road index. The environmental variables of distance to major open spaces, distance to lakes, air pollution, elevation, the stream index, and the open space index are considered (see the discussion of data in the next section).

The housing density equations are estimated using cross-sectional data. Because the block size and characteristics of residential decisions are different across the blocks, heteroscedasticity is likely to be present. The null hypothesis of no heteroscedasticity is tested using the Lagrange multiplier (LM) test suggested by Greene (1997, p. 653-58). The null hypothesis is rejected at the 1% significance level for each equation. Heteroscedasticity is corrected using the technique suggested by Kmenta (1986, p. 270-76). The transformed equation system is then estimated using the SUR estimator. A test for selectivity bias is a test for $\theta_j = 0$, $j = 1, 2, 3, 4$. If the null hypothesis of $\theta_j = 0$ is rejected, there is self-selection in choosing a type of community, j , and estimation without the self-selection variable will be biased.

It is a challenge to incorporate all the independent variables for the housing density equations because there may be multicollinearity among them. Although there have been many suggestions about how to detect multicollinearity, there are no certain guidelines. A commonly used rule is that if the correlation coefficient between the values

of two regressors is greater than 0.8 or 0.9, then multicollinearity is a serious problem. The correlation coefficients are reported on Table A-1 in the Appendix. Few of the correlation coefficients are shown to be close to 0.8 (e.g., correlation between housing values and education level, income and education level, housing values and income, and road index and population density). The seriousness of the multicollinearity is examined by deletion of the regressors involved with high correlation coefficients. We did not detect serious fluctuations in the coefficients, nor serious changes of statistical significance resulting from the deletion of the regressors with high correlation coefficients (see Table A-2 in the Appendix). Thus, the suspected multicollinearity is not a serious problem in the housing density equation.

STUDY AREA AND DATA

The area of our study is the Blue Ridge province of the Southern Appalachian Highlands; it includes all of the mountainous portions of western North Carolina, northern Georgia, southeastern South Carolina, eastern Tennessee, southwestern Virginia and southeastern West Virginia. Within this region, 3,687 blocks of the 1990 U.S. Census are used (see Figure 1). The eastern portion of the region is dominated by the Blue Ridge Mountains, which rise abruptly from the Piedmont province, forming a rugged and diverse landscape. Regionwide, the area of developed land has increased considerably over the past 20 years. Much of this development has been at the expense of cropland and pasture. Though the region has the greatest concentration of federally-owned land in the eastern United States, the vast majority of the region's land is privately owned. The population of the region increased by 27.8 percent between 1970 and 1990. Despite this growth, the population density in the study area remains below the average for the six states that contain the study area (U.S. Forest Service 1996).

Two principal data sources were used in this study: Applied Geographic Solutions, Thousands Oaks, California, which collects demographic, housing, crime risk and pollution data from the U.S. Census, the FBI and the EPA; and Geography Network, a web service which provides geographic data from the Environmental System Research Institute (ESRI), Redlands, California. The ArcView, computer software was employed to generate the database, using the data from the two principal sources. Distance calculations were made using a raster system where all data were arranged in grid cells. Distances were measured as the Euclidean distance from the centroid of the census block to the nearest edge of a feature. The sum of length and the sum of area were calculated using ArcScripts downloaded from ESRI. The census blocks are bounded on all sides by visible features, such as streets, roads, streams, and railroad tracks, and by invisible boundaries, such as cities, towns, townships, and county limits, property lines, and short, imaginary extensions of streets and roads. The census blocks in remote areas may be large and irregular and may contain many square miles (U.S. Census Bureau 1990).

The dependent variable of the community choice model is a community index. We constructed an index to classify each block into urban-dominant, urban-moderate, rural-moderate and rural-dominant communities. The classification is based on information about housing types from the U.S. Census. The U.S. Census divides housing types into urban core, urban non-core, rural farm, and rural non-farm, based on the population of each block. Specifically, we calculated the ratio of housing types of urban core and urban non-core to all housing types for each block. A block is identified as an urban-dominant community if all the housing types of each block are urban core or urban

non-core. 554 blocks of 3,687 blocks or 1 % of the total study area are identified as urban-dominant communities. A block is identified as an urban-moderate community if the percent of urban core and urban non-core housing is greater than or equal to 50 % and less than 100 %. A total of 1,027 blocks or 6 % of the total area are identified as urban moderate communities. A block is identified as a rural-moderate community if the percent of rural farm and rural non-farm housing is greater than 0 % or less than 50 %. 495 blocks or 10 % of the total area are identified as rural-moderate communities. A block is identified as a rural-dominant community if all the housing types of each block are rural farm or rural non-farm. A total of 1,611 blocks or 83 % of the total area are identified as rural-dominant communities.

The dependent variable for the housing density equation is the housing density of each block. The housing density is the number of houses per km² of area. It is the ratio of the total number of houses of the urban core, urban non-core, rural farm, and rural non-farm types to the area of each block in km². The dependent variables, explanatory variables and their definitions are shown in Table 1. Descriptive statistics for the variables are given in Table 2.

Estimation Results

Estimates of the Community Model

Parameter estimates for the multinomial logit model are presented in Table 3. The multinomial logit models the probabilities of households in an urban-dominated community relocating to other communities because the base of community choice is set to be an urban-dominated community, in our estimation. The marginal effects of independent variables on the choices between staying in an urban-dominant community and relocating to other communities are shown in Table 4. Sixteen of eighteen marginal effects are significant at the 1 % level, indicating that the model fits the data well.

The results show that community choice is significantly affected by the household characteristics of education level and political view. Education level is positively correlated with a choice of urban-moderate community, but it is negatively correlated with choices of rural communities. More educated households in an urban-dominated community are more likely to relocate to an urban-moderate community, but they are less likely to relocate to rural communities. Political view is correlated with choices of non-urban dominated communities (urban-moderate, rural-moderate and rural-dominant communities). The more conservative households in the urban-dominated community are more likely to relocate to other communities. These results indicate that more educated households choose to move toward urban communities, while conservative households choose to move away from urban-dominated communities.

The results show that community choice is significantly affected by the community attributes of population density, crime level, stability, and pollution. Population density and crime rate are all negatively correlated with the choices of non-urban dominated communities. Households that are currently located in urban-dominated communities are less likely to relocate to other communities experiencing increases of population density and/or crime rate. Households of an urban-dominated community are more likely to relocate to other communities with a greater stability. Urban-dominated households are more likely to relocate to rural communities with lower levels of air

pollution. However, the relocation of households from urban-dominated communities to urban-moderate communities is not significantly affected by pollution level, reflecting little difference in the air pollution level between urban-dominated and urban-moderate communities. These results indicate that households choose to live in less-urbanized communities for safety, less crowding, more stability and a less air-polluted environment.

Estimates of the Housing Density Model

The results of the housing density models of the four different types of communities are shown in the Table 5. Of the seventy-six housing density coefficients (nineteen variables in each of the four equations), thirty-seven are significant at the 5 % level. The system weighted R^2 is between 0.84 and 0.91.

The self-selection variables are taken from the multinomial logit model. There is substantial evidence that self-selection occurred in the households' choices of communities. The coefficient of the self-selection variable is statistically significant at the 1 % level in the housing equations for rural communities. It is also statistically significant at the 5 % level in urban housing equations. These results suggest that the community choices have different effects on the communities themselves. This implies a distinctive heterogeneity in the characteristics found in the community types observed in the region.

The parameter estimates of the housing density equations for different communities show that variables affecting housing density vary across the communities. Housing densities are affected more by socioeconomic variables in urban communities, while they are affected more by environmental variables in rural communities. Of the twenty-four socioeconomic coefficients (twelve variables in each of the dominant and moderate equations), sixteen in the urban communities and nine in the rural communities are statistically significant at the 5 % level. Of the twelve environmental coefficients (six variables in each of the dominant and moderate equations), no variables in the urban communities and eight in the rural communities are statistically significant at the 5 % level.

The effects of socioeconomic variables on housing densities across urban and rural communities also vary, even though the difference in socioeconomic effects is not as drastic as the difference in environmental effects. Population density, crime rate, education, political view, travel time to work, and road index commonly affect housing density in both urban- and rural-dominated communities. A higher population density requires more housing. The marginal effects of population density on the urban communities are higher than those of the rural communities. This suggests that an equal increase in population density increases housing density more in the urban communities than it does in the rural communities. This finding provides evidence that housing developments in urban communities are more responsive to increased population than housing developments in rural communities. A lower crime rate and higher levels of education attract more housing, either in urban-dominated communities or rural-dominated communities. The marginal effects of these two variables in the urban communities are higher than those in the rural communities. They indicate that safety and the education level of the community are common concerns of urban and rural households, but the degree of the concern is greater in the urban communities. A less conservative political viewpoint is correlated with more housing. An increase in the travel time to work increases with housing density. This suggests that people of the

region are indifferent to driving longer distances to meet their other housing requirements. The coefficient for the road index is positive and statistically significant at the 1 % level in both urban- and rural-dominated communities. This suggests that road accessibility is important to houses in any type of community.

Housing value, income, stability, and the distance to major roads have significant effects on housing density in urban communities, but they are not significant in rural communities. Housing density is negatively associated with housing value in urban communities. This is evidence that supports the notion that the more sparsely-developed houses in an urban area are more highly-priced. Housing density is positively associated with income in urban communities and is negatively associated with the stability of households in urban communities. This indicates that households in stable urban communities prefer to not be located in densely developed housing. Housing density is higher in urban-dominated communities, where the houses are closer to a major road.

Four of six environmental variables are statistically significant at the 1 % level in the rural-dominated communities. Rural dominated households are more likely to locate in the blocks that are closer to lakes, at higher elevations, and with greater access to streams and open space. Environmental variables did not have a substantial impact on the housing densities of urban communities. Clear differences in the effects of environment factors on housing densities between urban and rural communities imply heterogeneity in the characteristics found in the community choices observed in the region; this confirms significant self-selection.

All coefficients for the distance to a lake are negative across the urban and rural communities, although the coefficients of only the rural communities are significant at the 5 % level. This shows that both urban and rural households enjoy the environmental amenities of lakes but the attractions are only substantial to rural households. Elevation and access to streams are statistically significant at the 1 % level in both rural-moderate and rural-dominated communities. This indicates that the environmental amenities of higher elevation and a greater access to streams draw a substantial number of households to rural communities. The coefficient for the open space index is positive and statistically significant at the 1 % level only in rural-dominated communities. This suggests that access to open space is significantly important only to rural-dominated households.

Distance to the closest city is not a significant factor across the communities, and distance to the closest major city is not a significant factor in urban communities. This result may be explained by the relatively smaller and fewer cities observed in the region. The impact of distance to the closest major city is positive and significant at the 1 % level only in rural-dominant communities. This implies that rural-dominated households enjoy remoteness more than the positive utilities of being close to major cities. Air pollution is not a significant factor in housing decisions across the communities, perhaps reflecting that air quality under each community choice of the region is relatively homogeneous. Thus, the air quality is not a significant factor of housing choice within each community, even though it is a significant factor of alternative community choices, as shown in the estimates of the community model.

CONCLUDING REMARKS

This paper makes the first attempt to develop a spatial econometric model that combines broad units and fine-scale units with the application of GIS. The importance of our findings lies in their ability to present a coherent multi-scale model of housing decisions in the Southern Appalachian region.

The first-stage analysis yields estimates of the marginal effects of household characteristics and community attributes in community choices. We found that people who choose to live in less-urbanized communities value safety, less crowding, more stability, and a cleaner environment. The second-stage analysis yields the marginal effects of the socioeconomic and environmental characteristics in the residential choices for different communities. There is a distinctive heterogeneity of the characteristics found in the community choices observed in the region. The socioeconomic motives of urban communities and the environmental motives of rural communities are more weighted in their housing decisions. Specifically, housing development in urban communities is more responsive to increased population density than housing development in rural communities. Safety and the education level of the community are a greater concern to urban households. More sparsely developed houses in urban communities are more highly-priced. The higher income in urban communities attracts more housing. Households in stable urban communities dislike being located in densely-developed housing. Houses are more likely to be closer to a major road in urban-dominated communities. On the other hand, the environmental amenities of proximity to a lake, higher elevation, greater access to streams, and greater access to open spaces draw a substantial number of households to rural communities.

Based on the results of our study, growth drivers play out in distinctive ways in different community types. These distinctively different growth drivers imply that growth of an area has to be managed differently according to community type. These findings indicate that as development proceeds, shifts between community types will bring changes in their social structures. These changes will likely give rise to conflict as development proceeds and will have implications for how subsequent development might be organized across a landscape.

One of the weaknesses of the study is in the resolution of the block level in the site-specific housing choice model. Housing choices at an individual level could be used for a better analysis of more fine scale units if the individual housing data were readily available. This data set can be built using a database of individual houses from county tax assessors' offices, the census dataset of block levels, and the GIS database that can be created using information about individual houses. While collecting a dataset from the 98 counties of the Southern Appalachian region would be extremely expensive, a sample study for some selected counties in which all the types of communities are contained might be feasible.

The next step to this research might be to develop predictive models of land use choice that incorporate socio-economic and environmental influences at the micro level. Another direction for further research would be to address the conflict between old settlers and newcomers to the region. This region is increasingly divided into social structures of old settlers and newcomers who move to this area mainly in pursuit of

retirement, vacation homes and second homes. The interests of these two groups conflict in many ways, including in the area of housing decisions. The models we used in this study can be modified to investigate the heterogeneity of these two groups in the area.

ACKNOWLEDGEMENT: We would like to thank Barrie Collins and Tripp Lowe for their assistance in data analysis, and Dawn Black and Carol Hyldahl for their useful comments. This material is based upon work supported by the NSF funded Coweeta Long Term Ecological Research, the USDA Forest Service, and the Warnell School of Forest Resources of the University of Georgia.

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Table 1. Definition of Variables

Variable	Definition
Dependent Variables	
Community index	Index for a type of community of urban-dominant, urban-moderate, rural-moderate, rural-dominant
Housing density	Number of houses within 1 km ² of area
Socioeconomic Variables	
Housing value	Median value of owner-occupied houses in \$1,000
Income	Per capita income in \$1,000
Population density	Population within 1 km ² of area
Crime rate	Number of reported crimes, from vehicle theft to murder
Stability	Ratio of occupancies with 5 years or more to total occupancies
Education	Median school years
Political view	Ratio of population with political outlook very conservative and somewhat conservative to total population
Travel time to work	Travel time to work per employee in minutes
Distance to any city	Distance from a center of each block to the nearest city, town or village in km
Distance to major city	Distance from a center of each block to the nearest city with more than 50,000 population in km
Distance to major road	Distance from a center of each block to the nearest primary highway with limited access, interstate highways and toll highways, in km
Road index	Total distance of all roads in km within 1 km ² of area
Environmental Variables	
Distance to major open spaces	Distance from a center of each block to the nearest major open space including national park service land, national forest or other federal land, state or local parks or forests in km
Distance to lakes	Distance from a center of each block to the nearest major lake or reservoir in km
Pollution	NO ₂ level
Elevation	Mean elevation of each block in km
Stream index	Total distance of streams and rivers of each block in km within 1 km ² of area
Open space index	Ratio of total area of major open space to total area of each block

Table 2. Descriptive Statistics of Variables

	Initial	Mean	Min	Max	Std. Dev.
Dependent Variables					
Community index	CI	2.14	1	4	1.14
Housing density (per km ²)	HD	0.16	0	6.15	0.26
Socioeconomic Variables					
Housing value (\$1,000)	HV	59.79	0	330.77	24.66
Income (\$1,000)	IC	12.14	0	64	4.65
Population density (per km ²)	PD	0.36	0.0007	20.04	0.64
Crime rate	CR	78.23	1	558	73.66
Stability (%)	ST	0.59	0	1	0.13
Education (year)	ED	11.54	7.55	16.4	0.87
Political view (%)	PV	0.42	0.22	0.52	0.06
Travel time to work (min)	TW	19.40	2.5	62	5
Distance to any city (km)	DA	5.10	0.05	28.07	3.86
Distance to major city (km)	DM	51.28	0.27	165.69	37.42
Distance to major road (km)	DR	12.00	0	79.82	14.14
Road index (km)	RI	0.019	0	0.08	0.01
Environmental Variables					
Distance to major open space (km)	DO	16.63	0	60.55	10.81
Distance to lake (km)	DL	6.74	0	51.97	6.38
Pollution	PL	88.50	55	129	12.26
Elevation (km)	EL	0.45	0.20	1.34	0.22
Stream index (km)	SI	0.004	0	0.12	0.0028
Open space index (%)	OS	0.004	0	0.97	0.04

Table 3. Parameter Estimates for the Multinomial Logit Model of Community

Choices	Urban-Moderate	Rural-Moderate	Rural-Dominant
Constant	-1.9565 ^{**}	3.3455 ^{**}	7.2635 ^{**}
Education	0.1083 ^{**}	-0.2896 ^{**}	-0.6181 ^{**}
Political view	1.3222 [*]	1.9548 ^{**}	2.0088 ^{**}
Population density	-3.9594 ^{**}	-61.7434 ^{**}	-166.507 ^{**}
Crime rate	-0.0027 ^{**}	-0.0146 ^{**}	-0.0134 ^{**}
Stability	1.7098 ^{**}	2.0769 [*]	4.2697 ^{**}
Pollution	0.0069	-0.0141	-0.0195

Note: Log likelihood, -2938.72; ** indicates statistical significance at the 1 % level; * indicates statistical significance at the 5 % level

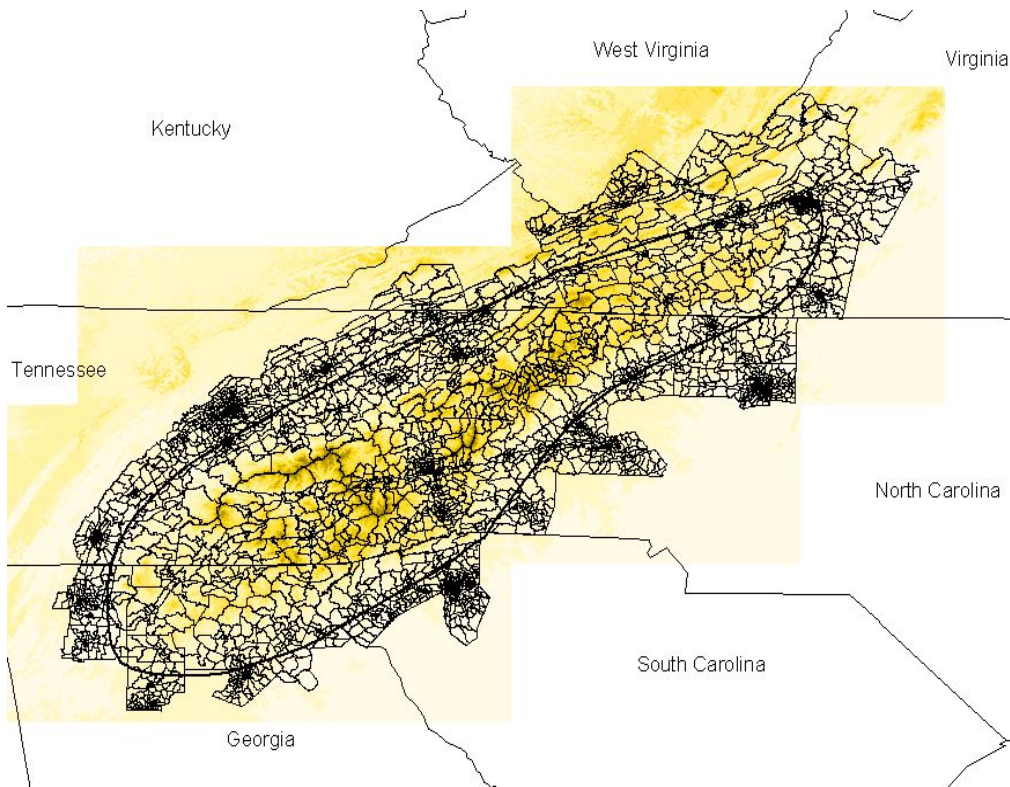
Table 4. Estimated Marginal Effects for Community Choices

	Urban-Moderate	Rural-Moderate	Rural-Dominant
Education	0.8998**	-2.9075**	-3.9944**
Political view	0.3998*	0.7143**	0.4725**
Population density	-1.0263**	-19.3380**	-33.5678**
Crime rate	-0.1521**	-0.9937**	-0.5871**
Stability	0.7263**	1.0661**	1.4107**
Pollution	0.4397	-1.0856**	-0.9664**

Table 5. Parameter Estimates for the Housing Density Equations for Alternative Community Choices

	Urban-Dominant	Urban-Moderate	Rural-Moderate	Rural-Dominant
Constant	-0.3082 [*]	0.1192 ^{**}	-0.0342	-0.0856 ^{**}
Socioeconomic Variables				
Housing value	-0.0016 ^{**}	-0.0003 [*]	-0.0001	-0.00003
Income	0.0066 ^{**}	0.0036 ^{**}	0.0001	-0.00004
Population density	3.4983 ^{**}	3.7256 ^{**}	3.0718 ^{**}	3.1338 ^{**}
Crime rate	-0.0001 [*]	0.00004	-0.00003	-0.00001 [*]
Stability	-0.1283 ^{**}	-0.0250	0.0148	-0.0013
Education	0.0216 ^{**}	-0.0155 ^{**}	0.0008	0.0052 ^{**}
Political view	-0.1289 [*]	-0.0008	0.0093	-0.0063 ^{**}
Travel time to work	0.0032 [*]	0.0010 [*]	0.0001	0.0002 ^{**}
Distance to any city	0.0036	0.0010	-0.0002	0.0001
Distance to major city	0.00002	-0.00002	-0.00002	0.00002 ^{**}
Distance to major road	-0.0024 ^{**}	0.0002	0.0001	0.00003
Road index	5.8219 ^{**}	2.5552 ^{**}	1.9362 ^{**}	1.9115 ^{**}
Environmental Variables				
Distance to major open spaces	0.0002	-0.00005	0.0001	0.00005 [*]
Distance to lakes	-0.0005	-0.0004	-0.0002 ^{**}	-0.00007 ^{**}
Air pollution level	-0.0002	-0.0003	0.0001	0.00002
Elevation	-0.0353	0.0200	0.0175 ^{**}	0.0077 ^{**}
Stream index	-1.3668	-0.5716	2.1383 ^{**}	1.7497 ^{**}
Open space index	0.0749	0.0475	0.0326	0.0171
Self-Selection Variable				
λ	0.0440 [*]	0.0033 [*]	-0.0064 ^{**}	0.0002 ^{**}
System weighted R ²	0.90	0.86	0.84	0.91

Figure 1. Study Area



Appendix

Table A-1. Correlation Coefficients of Variables Considered for Housing Density Model

	D	R	T	D	V	L	V	C	W	A	M	R	I O	L
D														
R	.39													
T	0.37	0.19												
D	.19	.14	0.37											
V	0.	0.07	.06	0.07										
L	0.08	.18	0.08	.10	.05									
V		.03	0.27	.72	0.01	.22								
C	0.05	.12	0.11	.69	0.03	.17	.79							
W	0.34	0.30	.27	0.27	.12	0.02	0.11	0.14						
A	0.33	0.23	.24	0.15	.06	0.03	0.03	0.09	0.14					
M	0.27	0.33	.26	0.29	.05	0.44	0.26	0.28	.07	.14				
R	0.26	0.25	.16	0.16	.05	.15	0.07	0.19	.17	.25	.43			
O	0.05	.10	.06	0.07	.08	.22	0.06	0.05	.06	.04	0.05	.10		
L	0.04	0.09	.12	0.13	.01	0.22	0.16	0.15	.12	.07	.21	.04	.07	
L	0.17	0.26	.18	0.07	0.09	0.29	0.09	0.19	.09	.21	.46	.35	0.11	.17
I		.02	0.06	0.04	.02		.01	0.01	0.06	0.02	.03	.03	0.06	0.07
S	0.04	0.01	.02	0.01	.01	.01		0.03	.02	.10	.04	.03	0.14	0.08
I	.74	.53	0.35	.18	0.10	.02	0.01	.05	0.49	0.35	0.33	0.35	0.05	0.07

Table A-2. Parameter Estimates for the Housing Density Equations under Alternative Community Choices without Variables (Income, Education Level, and Road Index) to Check Multicollinearity

	Urban Dominant	Urban Moderate	Rural Moderate	Rural Dominant
Constant	-0.3090 [*]	0.1233 ^{**}	-0.0338	-0.0863 ^{**}
Socioeconomic Variables				
Housing value	-0.0018 ^{**}	-0.0005 [*]	-0.0001	-0.00004
Population density	3.5814 ^{**}	3.7269 ^{**}	3.0725 ^{**}	3.1348 ^{**}
Crime rate	-0.0003 [*]	0.00004	-0.00004	-0.00003 [*]
Stability	-0.1292 ^{**}	-0.0252 [*]	0.0151	-0.0022
Political view	-0.1297 [*]	-0.0009	0.0098	-0.0069 ^{**}
Travel time to work	0.0037 [*]	0.0014 [*]	0.0001	0.0002 [*]
Distance to any city	0.0038	0.0010	-0.0002	0.0002
Distance to major city	0.00003	-0.00003	-0.00004	0.00003 ^{**}
Distance to major road	-0.0026 ^{**}	0.0002	0.0001	0.00003
Environmental Variables				
Distance to major open spaces	0.0002	-0.00006	0.0001	0.00005 [*]
Distance to lakes	-0.0005	-0.0005	-0.0003 ^{**}	-0.00007 ^{**}
Air pollution level	-0.0002	-0.0004	0.0001	0.00003
Elevation	-0.0359	0.0214	0.0179 ^{**}	0.0079 ^{**}
Stream index	-1.3674	-0.5721	2.1391 ^{**}	1.7503 ^{**}
Open space index	0.0753	0.0481	0.0332	0.0176 ^{**}
Self-Selection Variable				
λ	0.0444 [*]	0.0038 [*]	-0.0069 ^{**}	0.0003 ^{**}
System weighted R ²	0.86	0.85	0.82	0.90

Understanding Public Preferences for Alternative Silvicultural Systems Using Mixed Logit Models

Thomas P. Holmes and Elizabeth Murphy

Abstract: In this paper, we show how silvicultural systems can be modeled as sets of management attributes and how value tradeoffs among management attributes can be measured using survey methods. The valuation method we use is based on a new class of stated preference models generally referred to as “attribute-based methods”. Seven forest management attributes were included in our experiment. Management attributes were randomly combined into four different management plans and survey participants were asked to choose their most preferred plan. Data were obtained for a random sample of 278 residents in the state of Maine. Responses were analyzed and compared using two members of the family of Random Utility Maximization models. First, a Multinomial Logit (MNL) model was estimated to provide baseline results. Second, a Mixed Logit model was estimated which allowed us to evaluate the importance of preference heterogeneity on the value of forest management attributes. Our results showed that the Mixed Logit model was more informative than the standard MNL model. We discuss the importance of using public surveys for uncovering preferences for alternative silvicultural systems, and the benefits of understanding preference heterogeneity across the population for the design of socially desirable forest management systems.

Forest Management Activities And Expenditures Of Mississippi

NIPF Landowners: 1998-2000 Data¹

Kathryn G. Arano² and Ian A. Munn³

Abstract. Expenditures data provide a wealth of information with potential uses in a broad range of applications. Such data collected over time provide information about costs associated with forestland ownership, management practices implemented by NIPF landowners, and changes in management intensity over time. A survey of Mississippi NIPF landowners was conducted to determine their annual forest management expenditures for the period 1998-2000. Landowners were asked how much they spent on two major expenditure categories: (1) silvicultural expenses, which include site preparation, planting, and intermediate treatments; and (2) overhead expenses, which include property taxes, fees for professional services, routine expenses, hunting costs, and miscellaneous expenses. The resulting expenditures data were summarized in three ways: frequency of occurrence, mean expenditures per acre-owned for all respondents, and mean expenditures per acre treated for those respondents engaged in each activity. With the exception of property taxes, fewer than 12% respondents reported annual expenditures for any specific activity in any year during the survey period. Total expenditures for all respondents averaged \$11.51/acre-owned. This represents an annual outlay of \$146 million when extrapolated to the state level. Site preparation and planting represented the largest components of silvicultural expenses. Property taxes and miscellaneous expenses comprised the majority of overhead expenses.

Key Words: Silvicultural expenses, Overhead expenses, Property tax

INTRODUCTION

Long-term timber supply depends on the existing timberland base and on the extent of the investment or management intensity of non-industrial private forest (NIPF) landowners (Adams and Haynes 1991). Therefore, accurate estimates of timberland ownership and detailed information about forest management practices are necessary. Timber management intensity by these landowners constitutes one of the major uncertainties of timber supply modeling. Not surprisingly, management intensity and investment behavior can have a major impact on projected timber supply (Adams et al. 1982). However, little information is available on NIPF landowners' investment in forest management activities. While a number of studies have estimated the cost of various forest management practices (See Dubois et al. 1997, 1999, 2001), the actual dollar amounts invested by NIPF landowners are often not readily available. Arano et al. (2002) investigated the forest management activities and expenditures of NIPF landowners but did not determine treatment costs per acre or total acres treated.

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Expenditure information indicates landowners' willingness to invest in timber production. A measure of landowners' capital investment in various forestry activities, specifically in silvicultural activities, can be used in assessing forest management intensity level. Moreover, detailed information about expenditures incurred by private landowners over time will demonstrate how investments on private forestlands are distributed among various management or silvicultural activities and could provide useful benchmark information for landowners. Expenditures for various activities may also reflect landowner rankings of the relative profitability of various treatments and provide additional insights into landowner intentions. Finally, such information could also provide an estimate of the economic contribution of the different forestry activities to the state's economy.

This study examines the forest management activities and expenditures of NIPF landowners in Mississippi from 1998 to 2000. While expenditure data is collected annually, the analysis was limited to the three-year period because of differences in the sampling procedures and survey instrument used during the previous survey periods.

METHODS

Study Population

The study population consisted of NIPF landowners who own at least 20 acres of uncultivated lands in Mississippi. Uncultivated land refers to those rural land-uses other than agriculture, the majority of which are forest-related. The 20-acre threshold was chosen to eliminate non-forestry uses (e.g., home sites). Landowners who own less than 20 acres account for only 8.5% of the state's uncultivated acreage (Doolittle 1996).

Data

The Social Science Research Center at Mississippi State University conducted an annual mail survey of NIPF landowners to determine their annual forest management activities and associated expenditures for the period 1998-2000. Survey procedures followed Dillman's (1978) Total Design Method (TDM). At least 400 usable responses were targeted to achieve a 5% sampling error at a 95% confidence level.

The survey instrument was designed to elicit information from NIPF landowners about the area of forestland they own in Mississippi, their annual forest management activities and associated expenditures. Expenditures were grouped into two major categories: silvicultural and overhead expenses. Silvicultural activities included site preparation (mechanical treatments, chemical treatments, burning and fertilization), planting, and intermediate treatments (prescribed burning, fertilization, pruning, chemical release, pre-commercial thinning, and timber stand improvement). Overhead expenses included property taxes, fees for professional services (consulting forester, attorney, accountant, and surveyor), routine expenses (property line maintenance, protection, road maintenance, animal damage control, and supervision and administration), hunting costs (only costs associated with commercial hunting activities, e.g., leases, not personal hunting), and miscellaneous expenses (road construction, timber sales, others). Since the survey was designed to determine the cost per acre for the various treatments, the number of acres treated for the silvicultural activities was also elicited.

Analysis

To illustrate the frequency and distribution of forest management activities, the percentage of respondents who incurred expenditures for each forest management activity was computed. This percentage was computed for each survey year and for the three-year period.

Next, to illustrate the magnitude of forest management expenditures for NIPF landowners as a group, the sample means for the reported expenditures for each activity on a per-acre-owned basis for all respondents for each survey year were computed. In computing the mean, per-acre expenditures were weighted by the number of acres owned. The responses to the annual surveys were pooled to calculate average annual expenditures over the three-year period.

Sample means provide useful information about population-level expenditures, however, they do not necessarily provide useful information about treatment costs. Therefore, mean expenditures per acre treated for silvicultural activities and the mean expenditures per acre owned for overhead expenses were also computed. Mean expenditures for silvicultural activities were weighted by the number of acres treated and overhead expenses were weighted by the number of acres owned.

Expenditures were compared on the basis of frequency of occurrence as well as magnitude. Pairwise t-tests in SAS were used to determine whether management expenditures changed significantly over the study period using $\alpha=0.05$ level of significance.

Expenditures were extrapolated to the state level to determine the economic contribution of forest management to the state's economy. Statewide estimates were computed by multiplying total expenditures per acre owned by the acres of Mississippi NIPF timberland in ownerships larger than 20 acres.

RESULTS

The mail surveys resulted in 1,605 usable responses for the three-year period, a 35% response rate. In light of the low response rate, there was a concern about response bias. Therefore, the distribution by ownership size of the respondents was compared to that of the statewide population of forestland owners (Figure 1). The smallest ownership size class (20-49 acres) is under-represented in the sample. In Mississippi, this ownership class owns less than 17% of the total NIPF area in ownerships 20 acres or larger. Nonetheless, the response bias by ownership size may potentially bias the survey results. Therefore, ownership size was regressed on per-acre expenditures and no significant relationship was found ($F=0.03$, $p=0.85$). Thus, although the survey response rate varies by ownership size class, this response bias is unlikely to bias the sample means calculated for this study.

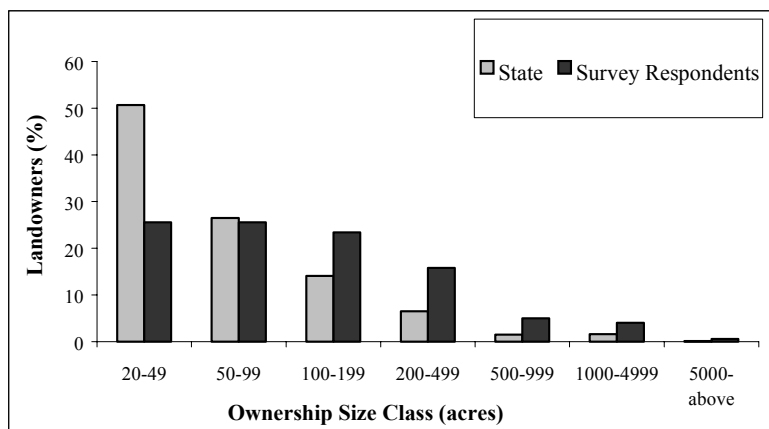


Figure 1. Comparison of the distribution of Mississippi NIPF landowners by ownership size class for survey respondents and the population of state landowners.

Forest Ownership

The average ownership size reported over the three-year study period was 261 acres (Table 1). This compares to an average ownership size of 99 acres for the statewide population (Doolittle 1996), again demonstrating the under representation of the smallest ownership size in the sample. The average area owned did not vary significantly over the study period.

Pine plantations constitute the largest forest type owned by NIPF landowners in Mississippi. The average acreage of pine plantations owned for the three-year study period was 76 acres, which represents 26% of total timberland area. Plantation pine was the largest forest type for each year.

Table 1. Average acres of timberland owned by NIPF respondents in Mississippi, 1998-2000.

Year	Planted Pine	Natural Pine	Mixed	Hardwood	Non-Typed	Total*
1998	64.53 ^a	52.74 ^a	45.53 ^a	55.41 ^a	17.67 ^a	240.87 ^a
1999	74.16 ^a	48.56 ^a	49.08 ^a	68.34 ^a	13.42 ^a	258.17 ^a
2000	87.84 ^a	66.52 ^a	49.78 ^a	62.64 ^a	11.55 ^a	281.22 ^a
3-Yr. Average	76.35	56.22	48.34	62.73	13.94	261.56

Note: Annual means in a given column that have the same letter are not significantly different from each other at $\alpha=0.05$.

*Acres owned under different forest types do not add up to total acres reported because some landowners failed to report acres owned under each forest type and reported total acres owned only.

Frequency of Occurrence

Most silvicultural activities occurred infrequently (Table 2). This is also the case with overhead expenses (Table 3). With the exception of property taxes, fewer than 11% of respondents reported annual expenditures for any specific activity in any year during the survey period.

Silvicultural Expenses

On average, approximately 16% of the landowners incurred silvicultural expenses each year of the survey period (Table 2). Site preparation and planting were the most frequently occurring silvicultural activities. Approximately 10% of landowners spent money on these activities each year. Among site preparation activities, chemical site preparation was the most commonly reported while fertilization was the least common.

Intermediate treatments were the least common silvicultural activities. Approximately 3% of landowners incurred intermediate treatments each year of the survey period.

Table 2. Percentage of NIPF respondents in Mississippi who incurred silvicultural expenses, 1998-2000.

<i>Expense Category</i>	----- Year -----			
	1998	1999	2000	3 Yr. Average
	----- (percentage) -----			
Site Preparation	8.99 ^a	8.81 ^a	10.70 ^a	9.53
Mechanical treatments	2.90 ^a	3.60 ^a	3.50 ^a	3.36
Chemical treatments	4.27 ^a	4.92 ^a	6.49 ^a	5.30
Burning	2.92 ^a	3.39 ^a	4.39 ^a	3.61
Fertilization	2.02 ^a	1.02 ^a	1.75 ^a	1.56
Planting	9.66 ^a	10.51 ^a	9.65 ^a	9.97
Intermediate Treatments	2.70 ^a	4.07 ^a	3.33 ^a	3.43
Prescribed burning	0.67 ^a	1.86 ^b	1.40 ^{ab}	1.37
Fertilization	0.90 ^a	1.19 ^a	0.70 ^a	0.93
Pruning	0.22 ^a	0.17 ^a	0.35 ^a	0.25
Chemical release	0.90 ^a	1.02 ^a	0.88 ^a	0.93
Pre-commercial thinning	0.00 ^a	0.17 ^a	0.35 ^a	0.19
Timber stand improvement	0.22 ^a	0.34 ^a	0.53 ^a	0.37
Total	14.61 ^a	15.76 ^a	16.14 ^a	15.58

Note: Annual means in a given row that have the same letter are not significantly different at $\alpha=0.05$.

Overhead Expenses

Most of the landowners incurred overhead expenses. Approximately 72% of landowners had this type of expense (Table 3). This relatively high percentage is attributed to the property taxes that landowners are required to pay regardless of whether they conduct any forestry activity or not. In fact, fewer than 10% of landowners incurred expenditures for any specific activity each year.

Approximately 65% of the respondents reported paying property taxes on their forestland during the survey period. Several respondents noted that they were unable to determine what portion of their tax bill was due to forestland versus agricultural land and therefore could not report the taxes paid on forestland. In counties where joint ownership of agricultural and forestland is prevalent, this would affect the number of non-responses.

Over the study period, an average of 11% of landowners reported paying fees for some type of professional service. Consulting foresters were the professionals most commonly used by landowners.

There was a significant increase in the percentage of landowners incurring routine expenses from 1998 to 2000. Property line maintenance and road maintenance were the most frequently occurring in this category. Supervision and administration was the least common expenditure.

Table 3. Percentage of NIPF landowners in Mississippi who incurred overhead expenses, 1998-2000.

Expense Category	-----Year-----			
	1998	1999	2000	3 Yr. Average
	----- (percentage) -----			
Property Taxes	53.48 ^a	64.41 ^b	75.61 ^c	65.36
Fees for professional services	9.21 ^a	12.54 ^b	11.23 ^{ab}	11.15
Consulting forester	3.37 ^a	5.42 ^b	5.09 ^{ab}	4.74
Attorney	1.35 ^a	3.39 ^b	2.46 ^{ab}	2.49
Accountant	4.04 ^a	4.24 ^a	4.56 ^a	4.30
Surveyor	3.15 ^a	3.73 ^a	2.81 ^a	3.24
Routine Expenses	13.93 ^a	17.46 ^b	18.07 ^b	16.70
Property line	9.00 ^a	9.15 ^a	9.47 ^a	9.22
Protection	4.27 ^a	4.92 ^a	4.56 ^a	4.61
Road maintenance	8.31 ^a	8.64 ^a	9.82 ^a	8.97
Animal damage control	-	3.73 ^a	4.21 ^a	3.97
Supervision and administration	2.25 ^a	3.22 ^a	1.93 ^a	2.49
Hunting Costs	5.84 ^a	6.95 ^a	9.30 ^b	7.48
Miscellaneous Expenses	13.03 ^a	11.69 ^a	12.63 ^a	12.40
Road construction	5.39 ^a	5.25 ^a	5.43 ^a	5.36
Timber sales	5.84 ^a	4.58 ^a	4.74 ^a	4.98
Others	4.49 ^a	4.24 ^a	4.91 ^a	4.55
Total	61.35 ^a	72.88 ^b	79.47 ^c	72.02

Note: Annual means in a given row that have the same letter are not significantly different at $\alpha=0.05$.

Few landowners incurred expenditures related to wildlife management. On the average, only 7% of landowners incurred hunting expenses associated with fee hunting endeavors each year during the study period. A higher percentage of landowners incurred miscellaneous expenses, averaging approximately 12% during the study period.

Mean Expenditures for all Respondents

Over the survey period, total annual expenditures averaged \$11.50/acre-owned. Silvicultural expenses in 1999 and 2000 were significantly higher compared to 1998 (Table 4). Overhead expenses in 2000 were significantly higher than those incurred by landowners in 1998 and 1999 (Table 5).

Silvicultural Expenses

Total silvicultural expenses averaged \$4.27/acre-owned during the 3-year survey period. Landowners spent the most on site preparation and planting and the least on intermediate treatments. All the major categories showed a significant variation in expenses over the study period. However, there were no significant variations across years for most of the sub-categories.

Expenditures for site preparation averaged \$2.10/acre-owned for all respondents. Chemical treatments accounted for more than half of this total. Planting expenses represented the second largest component of silvicultural spending, averaging \$1.80/acre-owned. Annual expenditures on intermediate treatments averaged \$0.39/acre-owned.

Overhead Expenses

Over the study period, total overhead expenses averaged \$7.24/acre-owned for all respondents (Table 5). Overhead expenses comprise the majority of landowner expenditures.

Table 4. Average silvicultural expenditures per acre owned for all NIPF respondents, Mississippi, 1998-2000.

Expense Category	----- Year -----			
	1998	1999	2000	3 Yr. Average
	-----(\$/acre- owned)-----			
Site Preparation	1.46 ^a	2.42 ^b	2.24 ^b	2.10
Mechanical treatments	0.21 ^a	1.12 ^b	0.46 ^c	0.63
Chemical treatments	1.07 ^a	1.20 ^a	1.52 ^a	1.29
Burning	0.07 ^a	0.08 ^a	0.16 ^b	0.11
Fertilization	0.10 ^a	0.02 ^b	0.10 ^a	0.07
Planting	1.49 ^a	1.54 ^a	2.25 ^b	1.80
Intermediate Treatments	0.21 ^a	0.38 ^b	0.51 ^b	0.39
Prescribed burning	0.01 ^a	0.06 ^b	0.03 ^{ab}	0.03
Fertilization	0.06 ^a	0.14 ^b	0.04 ^a	0.08
Pruning	0.01 ^a	0.01 ^a	0.03 ^a	0.02
Chemical release	0.13 ^a	0.16 ^a	0.07 ^a	0.12
Pre-commercial thinning	0.00 ^a	0.001 ^a	0.03 ^a	0.01
Timber stand improvement	0.003 ^a	0.01 ^a	0.31 ^b	0.13
Total	3.14 ^a	4.31 ^b	4.99 ^b	4.27

Note: Annual means in a given row that have the same letter are not significantly different at $\alpha=0.05$.

Table 5. Average overhead expenditures per acre owned for all NIPF respondents, Mississippi, 1998-2000.

Expense Category	-----Year-----			
	1998	1999	2000	3 Yr. Average
	-----(\$/acre-owned)-----			
Property Taxes	1.50 ^a	2.50 ^b	3.15 ^c	2.49
Fees for professional services	0.64 ^a	1.23 ^b	1.21 ^b	1.07
Consulting forester	0.44 ^a	0.91 ^b	0.73 ^b	0.72
Attorney	0.03 ^a	0.12 ^b	0.25 ^b	0.15
Accountant	0.06 ^a	0.07 ^{ab}	0.10 ^b	0.08
Surveyor	0.11 ^a	0.13 ^a	0.13 ^a	0.12
Routine Expenses	0.92 ^a	0.80 ^a	0.66 ^a	0.76
Property line	0.20 ^a	0.19 ^a	0.24 ^a	0.21
Protection	0.10 ^a	0.08 ^{ab}	0.05 ^b	0.08
Road maintenance	0.20 ^a	0.21 ^a	0.20 ^a	0.21
Animal damage control	-	0.08 ^b	0.11 ^b	0.10
Supervision and administration	0.43 ^a	0.23 ^a	0.05 ^b	0.21
Hunting Costs	0.29 ^a	0.28 ^a	0.20 ^a	0.25
Miscellaneous Expenses	4.83 ^a	1.71 ^b	2.10 ^b	2.66
Road construction	2.09 ^a	0.49 ^b	0.44 ^b	0.89
Timber sales	1.36 ^a	1.08 ^a	0.74 ^a	1.02
Others	1.38 ^a	0.16 ^b	0.92 ^a	0.76
Total	8.17 ^a	6.52 ^b	7.31 ^b	7.24

Note: Annual means in a given row that have same letter are not significantly different at $\alpha=0.05$.

Miscellaneous expenses represented the largest component of this category while hunting expenses represented the smallest. Property taxes, fees for professional services, and miscellaneous expenses varied significantly over the survey period. Overall, overhead expenses in 2000 were significantly higher compared to those in 1998 and 1999.

Annual property taxes averaged \$2.49/acre-owned for all respondents. Expenditures for professional services averaged \$1.07/acre-owned for all respondents. Consulting forester fees were the largest component representing more than half of the amount spent on professional services.

Routine expenses averaged \$0.76/acre-owned. Property line maintenance, road maintenance, and administration and supervision were the largest components of routine expenses. Annual hunting costs averaged \$0.25/acre-owned during the 3-year period. Miscellaneous expenses were the largest component of overhead expenses. In total, these expenditures averaged \$2.66/acre-owned for all respondents.

Total Expenditures

NIPF respondents in Mississippi spent an average of \$11.51/acre-owned for forestry activities during the 3-year survey period. Overhead expenses represent the largest component of landowners' total expenditures on forestry activities. Approximately 63% was spent on overhead activities. Only 37% was spent on silvicultural activities. Intermediate treatments only comprise 3% of total spending. When extrapolated to the state level, NIPF landowners' forest management expenditures represent an annual outlay of \$146 million for the 12,695,073 acres of timberland in Mississippi in ownerships larger than 20 acres (Doolittle 1996).

Mean Expenditures of Landowners Engaged in Management Activities

Silvicultural Expenses

Site preparation expenditures averaged \$57.24/acre-treated (Table 6). Per acre expenditures on chemical treatments were substantially greater than other site preparation activities. Planting averaged \$66.45/acre-treated over the 3-year survey period. Intermediate treatments averaged \$33.60/acre-treated.

Table 6. Average silvicultural expenditures per acre treated for NIPF respondents who incurred the expense, Mississippi, 1998-2000.

Expense Category	----- Year -----						3 yr. Average
	1998		1999		2000		
	\$/acre	n	\$/acre	n	\$/acre	n	
Site Preparation	47.91 ^{ab}	40	60.99 ^a	52	58.51 ^b	61	57.24
Mechanical treatments	46.22 ^a	13	112.59 ^b	21	72.12 ^b	20	88.17
Chemical treatments	72.42 ^a	19	58.16 ^b	29	80.15 ^a	37	69.68
Burning	9.06 ^a	13	10.14 ^a	20	14.89 ^a	25	12.05
Fertilization	32.15 ^a	9	28.00 ^a	6	47.76 ^a	10	38.11
Planting	48.18 ^a	43	66.62 ^a	62	73.92 ^c	55	64.45
Intermediate Treatments	32.41 ^a	12	27.20 ^a	24	40.77 ^a	19	33.60
Prescribed burning	12.31 ^a	3	8.69 ^a	11	8.11 ^a	8	9.09
Fertilization	29.61 ^a	4	39.93 ^b	7	18.84 ^c	4	30.78
Pruning	13.64 [*]	1	80.00 [*]	1	197.83 [*]	2	50.00
Chemical release	45.20 ^a	4	64.75 ^a	6	56.82 ^a	5	56.15
Pre-commercial thinning	-	-	20.00 [*]	1	57.67 [*]	2	53.24 [*]
Timber stand improvement	42.88 [*]	1	11.72 ^a	2	64.03 ^b	3	54.23
Total	46.56 ^a	65	56.03 ^b	93	61.52 ^b	92	56.12

Note: Annual means in a given row that have the same letter are not significantly different at $\alpha=0.05$.

*Not enough observation to compare.

Overhead Expenses

Annual overhead expenses per acre owned averaged \$8.45 for those landowners who incurred any type of overhead expense (Table 7). This is roughly 17% higher than the total annual overhead expenses reported for all respondents. Differences for specific management activities were substantially greater. Except for fees for professional services and routine expenses, overhead expenses changed significantly across years for each expense category and in total.

Property taxes averaged \$2.42, \$3.20, and \$3.57/acre-owned in 1998, 1999, and 2000, respectively, for landowners reporting such taxes. Fees for professional services averaged \$3.51/acre-owned. Consultant and surveyor fees were substantially greater than for any other professional services. Landowners who incurred routine expenses spent an average of \$2.38/acre-owned for the 3-year survey period. Property line maintenance, road maintenance, and supervision and administration were the most expensive activities under this category. Hunting expenses averaged \$1.76/acre-owned. Miscellaneous expenses averaged \$8.45/acre-owned.

Table 7. Average overhead expenditures per acre owned for NIPF respondents who incurred the expense, Mississippi, 1998-2000.

Expense Category	----- Year -----						3 Yr. Average
	1998		1999		2000		
	\$/acre	n	\$/acre	n	\$/acre	n	
Property Taxes	2.42 ^a	238	3.20 ^b	380	3.57 ^b	431	3.20
Fees for professional services	2.66 ^a	41	4.53 ^a	74	3.17 ^a	64	3.51
Consulting forester	4.34 ^{ab}	15	5.52 ^a	32	2.44 ^b	29	3.61
Attorney	0.32 ^a	6	1.08 ^a	20	1.72 ^a	14	1.24
Accountant	0.51 ^a	18	0.52 ^a	25	0.47 ^a	26	0.49
Surveyor	0.98 ^a	14	2.26 ^a	22	1.73 ^a	16	1.61
Routine Expenses	2.96 ^a	62	2.29 ^a	103	2.10 ^a	103	2.38
Property line	0.78 ^a	40	1.21 ^a	54	1.20 ^a	54	1.06
Protection	1.07 ^a	19	1.12 ^a	29	0.46 ^b	26	0.81
Road maintenance	0.94 ^a	37	1.05 ^a	51	1.17 ^a	56	1.06
Animal damage control	-	-	0.87 ^a	22	1.00 ^a	24	0.95
Supervision and administration	4.62 ^a	10	3.61 ^a	19	1.83 ^a	11	3.67
Hunting Costs	2.20 ^a	26	3.84 ^a	41	0.92 ^b	53	1.76
Miscellaneous Expenses	16.16 ^a	58	7.16 ^{ab}	69	5.30 ^b	72	8.45
Road construction	16.77 ^a	24	4.01 ^b	31	5.63 ^{ab}	31	8.35
Timber sales	7.15 ^a	26	8.19 ^a	27	3.11 ^b	27	5.46
Others	17.33 ^a	20	3.92 ^b	25	4.42 ^b	28	6.64
Total	10.85 ^a	273	7.41 ^b	430	8.06 ^{ab}	453	8.45

Note: Annual means in a given row that have the same letter are not significantly different at $\alpha=0.05$.

DISCUSSION AND CONCLUSIONS

Most forest management expenditures occur infrequently. A majority of landowners are not engaged in forestry-related activities in any given year. With the exception of property taxes, fewer than 11% of respondents reported annual expenditures for any specific activity in any year during the survey period. This is 4% less than those reported by Arano et al. (2002). Even when expenditures were aggregated into broader categories, the percentage of respondents incurring expenditures in these broad categories in any given year remained below 20%. These low

percentages suggest that little has changed since Dutrow and Kaiser's (1984) assessment of the investment opportunities in forestry. One possible reason for these low percentages is the nature of NIPF timberland holdings. Timberland holdings by NIPF landowners are predominantly in smaller tracts and are fragmented. Landowners with smaller, fragmented holdings have limited management options (Conner and Hartsell 2002). While NIPF landowners do not manage as intensively as industrial owners, these findings may suggest some serious problems for future timber availability in the South. Provencher (1990) reported that intensive management of NIPF timberlands is needed to substantially reduce future timber scarcity. This is particularly important because NIPF landowners control the majority of timberlands in the South.

Frequency of activities provides information on how private lands are being managed, which has an important bearing on their productivity (Thomas 1998). For example, planting and site preparation costs were the most common silvicultural expenditure reported, averaging 10% of the landowners over the study period. In contrast, expenditures on intermediate treatments were incurred by only 3.43%. Site preparation and planting activities are both considered intensive forest management practices (Dubois 1999).

Expenditures also reflect an informal ranking of forestry activities. Focusing strictly on activities directly related to timber growing, landowners view site preparation and planting as the most important silvicultural activities. A little over 90% of the money spent on silvicultural activities was spent on these two activities. In contrast, intermediate treatments (e.g. timber stand improvement, pruning) account for less than 10% of total silvicultural expenses. This provides evidence that landowners believe it more profitable to spend money on site preparation and planting compared to other silvicultural activities.

This study also illustrates an interesting aspect of investing in forestland. Only 43% of annual expenditures are directly related to timber production, either through enhancing timber growth or returns on sales. The remaining expenditures do not generate a direct return on investment in that they do not result in increased growth or increased returns on timber sales. These expenditures averaged \$6.52/acre-owned annually and account for 57% of total expenditures. Over a rotation, these amounts are substantial and may reduce the attractiveness of forestland investments, particularly for those investors concerned about cash flow requirements. These expenditures as a proportion of total expenditures have risen 12% since the 1995-1997 survey (Arano et al. 2002). Total expenditures have also risen by approximately 19% since the last study, averaging \$9.68/acre-owned in the 1995-1997 study versus \$11.51/acre-owned in this study. This trend indicates that most of the increase in landowner spending is due to increases in the non-productive costs associated with forest land ownership and not because landowners are managing more intensively. This provides evidence that non-productive costs will continue to constitute the majority of landowner expenses and may make timberland investment increasingly less attractive to landowners.

Forest management expenditures may provide a useful tool in timber supply modeling. Annual expenditures data provide a relative measure of management intensity over time and, as this study has demonstrated, are relatively easy to obtain. Such information collected annually in a consistent format and adjusted for inflation would provide a measure of changes in management intensity over time. Even without further refinement, this information would signal timber supply modelers when fundamental changes in management intensity occur, thus triggering investigations to identify the nature of the changes that are occurring. With further research, it may be possible also to establish a more direct relationship between expenditures and forest

productivity. In that case, expenditures information could be included as a determinant of timber supply in timber market models.

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Financial Evaluation of Thinning and Pruning Silvicultural Treatments on a Thirty Year Rotation of Old Field Pine Plantation in North Louisiana

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Abstract: Various pruning and thinning silvicultural regimes were applied to plots of planted loblolly pine (*Pinus taeda* L.) at the Hill Farm Research Station in northwest Louisiana and evaluated for production and financial returns over a twenty-nine year period. Eight alternative silvicultural regimes (a combination of two planting densities, two thinning ages, and two pruning ages) were evaluated with treatments occurring at ages 6 and 11. Field measurements and financial evaluation both indicate that the alternative in which trees were planted on a spacing of 10 feet by 10 feet, and pre-commercial thinning and pruning occurred at age 6 combined with a commercial thin and pruning treatment at age 11, yielded superior results.

INTRODUCTION

On a given site, loblolly pine (*Pinus taeda* L.) plantations of similar age and composition will produce the same total stem cubic-foot volume over a range of stocking densities. The biological objective of optimizing fiber production can be achieved by applying silvicultural practices such as chemical site preparation, artificial regeneration with genetically improved growing stock, herbaceous weed suppression and releasing crop pine trees from unwanted woody vegetation. However, short rotation fiber production may not provide landowners with a satisfactory rate of return on invested capital. Bond (1952) recognized the need to apply both biologic and economic principles to timber management. He stated, "Net returns are maximized when the growing stock is regulated and held to the smallest amount of timber capital that will produce maximum yield within the capacity of the site and species. With too much volume of growing stock the net return per acre may be high, but the rate of return on the large investment unsatisfactory. With too little growing stock the rate of return on the small investment is likely to be high but the net return per acre unsatisfactory." Thus, timber investment capital should be maintained at levels that can optimize financial gains for either short or long rotations, given an opportunity cost for capital, or interest rate.

The manner in which wood is distributed along individual tree boles influences the ultimate value of a plantation. Growing a small number of large diameter trees suitable for lumber and plywood can attain higher value. High-quality crop trees can be developed in rapidly growing plantations by applying thinning and pruning practices to manipulate pine stocking density, size-class composition, and individual tree form.

Research has indicated that thinning may not increase net merchantable yields in plantations with a rotation length of 25 years or less. Thinning young loblolly pine (*Pinus taeda* L.) stands in Illinois failed to increase yields at age 17 (Minckler and Dietschman, 1953). Crow (1952) found no yield difference between a light thinning (88 ft²/acre of residual basal area) and an unthinned control in 24-year old slash pine (*Pinus elliottii* Engelm.) plantations in south

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Louisiana, but thinned natural loblolly pine stands in Louisiana produced yield increases by age 33 (Mann 1952). Wahlenberg (1960) noted that yield increases subsequent to thinning resulted from increased net merchantable volume harvested during a rotation rather than increased total wood growth.

Loblolly, slash, and other pine plantations established at relatively wide spacings or grown under severe thinning schedules produced high yields during short rotations. In Australia, Jolly (1950) obtained the greatest volume yield and net return on investment during a short rotation by thinning Monterey pine (*Pinus radiata* D. Don) to 300 trees per acre (TPA) at age 10. Kotze (1960) recommended that loblolly and slash pine in South Africa planted at a 7 ft x 7 ft spacing should be thinned to 500 TPA at age 11 and 300 TPA at age 16. Harvest yields produced with this schedule were 850 and 1,275 ft³/acre at age 11, and 16 with 5,100 ft³/acre net merchantable volume at 25 years. Sprinz et al. (1979) found that total merchantable yields for loblolly pine thinned to 300 TPA at age 11 were comparable to an unthinned 10 ft x 10 ft treatment and greater than unthinned treatments with higher tree stocking densities.

Pruning, which enhances formation of knot-free wood, could contribute significantly to the development of premium sawtimber trees. When used in conjunction with thinning, pruning schedules can be developed to maximize knot-free wood formation. Labyak and Schumacher (1954) suggested pruning a selected number of crop trees in fully-stocked stands accompanied by a severe thinning to preclude further natural pruning. For pruning wider-spaced, old-field, slash pine plantations on good sites, Bennett (1955) recommended a two-step pruning schedule that maintained residual crown ratio at 50 percent with an initial pruning at age 5 or 6 followed by an additional pruning 6 years later. This two-step schedule applied to a thinned loblolly pine plantation did not reduce individual tree growth (Clason and Stiff, 1980), and Valenti and Cao (1986), found twice pruned trees had 4 percent less taper, 4 percent more wood volume and 9 percent more lumber volume than once pruned trees. Pruning schedules should be based on height, diameter and taper characteristics of the 100 largest trees per acre (Banks and Prevost, 1976) with the first pruning applied when crop tree diameters average 4.0 inches (Vel 1975). Locatelli (1977) stated pruning would be profitable, provided only crop trees are pruned and pruning is done on at least 7-acre blocks.

This paper evaluates the combined effect of thinning and one-and two-lift pruning schedules on the financial potential of a 29-year-old loblolly pine plantation growing in northwest Louisiana.

MATERIAL AND METHODS

Data were collected from a 29-year-old loblolly pine plantation located on the Hill Farm Research Station near Homer, Louisiana. Research plots were established on an abandoned cotton field that had been withdrawn from cultivation for 15 years with soil types mainly from the Shubuta, Luverne and Bowie Series, all having a fine sandy loam texture. Site index averaged 68 feet on a 25-year base with site quality of individual plots ranging from 65 to 78 feet. In February 1950, bare rooted seedlings, graded as 1 and 2 by Wakeley's (1954) grading system were planted. Seedlings were grown from loblolly seed collected by the Louisiana Forestry Commission from natural stands located in north Louisiana. Prior to planting, site preparation included cutting existing pine and hardwood saplings, applying herbicide to stump surfaces and burning the entire area.

Five planting densities, 4 x 4, 6 x 6, 6 x 8, 8 x 8, and 10 x 10-foot spacings, were established with each density being planted in two one-acre blocks. Survival rates were generally high but interplanting was done where necessary.

In 1955 at age 6, each block was sub-divided into 4 plots. Measurement areas ranged from 0.16 to 0.29 acres without buffer strips. Four cultural treatments were randomly assigned to plots in each block:

1. Check (Untreated spacing treatment)
2. Precommercially thin (PCT) to 400 trees per acre (TPA);
3. Prune (PRN) 400 crop TPA to 8 feet or 1/2 total height;
4. Precommercially thin to 400 TPA and prune to 8 feet or 1/2 total height (PCT x PRN).

From 1955 to 1960, diameter and height were measured annually. At age 11, three thinning and pruning treatments were applied to the age 6 culturally treated plots. Treatments included:

1. Thin to 100 TPA and prune to 18 feet;
2. Thin to 200 TPA and prune to 18 feet;
3. Thin to 300 TPA and prune to 18 feet.

The age 11 treatments were replicated three times on each age 6 cultural treatment and growth data were collected on a periodic basis from 1960 through 1978. During a commercial thinning in 1978, approximately 50 percent of the measurement trees were removed and taken to a sawmill to evaluate lumber quality. Individual tree stem volumes from this thinning were used to develop the local volume table (Clason and Cao, 1986). Tree volume data used in this study were computed with this table.

Since the initial planting density treatments affected early plantation development (Sprinz, et al., 1979), the financial impact of the thinning and pruning regimes on plantation value was restricted to the 8 x 8 and 10 x 10 foot planting densities. Subsequently, the four age 6 treatments and the 100 TPA age 11 treatment were combined factorially with the 8 x 8 and 10 x 10 foot planting densities creating the following 8 treatment combinations:

- A. 8 X 8 planting density, no thinning or pruning treatments;
- B. 10 X 10 planting density, no thinning or pruning treatments;
- C. 8 X 8 planting density, pre-commercially thinned at age 6, pruned at age 11, and commercially thinned to 100 trees per acre at age 11;
- D. 10 X 10 planting density, pre-commercially thinned at age 6, pruned at age 11, and commercially thinned to 100 trees per acre at age 11;
- E. 8 X 8 planting density, no pre-commercial thin, pruned at ages 6 and 11, and commercially thinned to 100 trees per acre at age 11;
- F. 10 X 10 planting density, no pre-commercial thin, pruned at ages 6 and 11, and commercially thinned to 100 trees per acre at age 11;
- G. 8 X 8 planting density, pre-commercially thinned at age 6, pruned at ages 6 and 11, and commercially thinned to 100 trees per acre at age 11; and
- H. 10 X 10 planting density, pre-commercially thinned at age 6, pruned at ages 6 and 11, and commercially thinned to 100 trees per acre at age 11.

Financial comparison among treatment combinations was made using actual harvest and revenue data combined with hypothetical cost data (Table 1). Some further assumptions were made in order to complete the economic analysis. Those assumptions included a land purchase at year 0 of \$300.00 per acre for all alternatives. All alternatives were site-prepared with an aerial application of herbicide combined with prescribed fire. Site preparation and planting also occurred in year 0. The aerial application of herbicides in conjunction with prescribed fire was

assumed to cost \$96 per acre. Tax and administration costs of \$3.50 per acre for all alternatives initially occurred in year 1 and every year thereafter until the end of the rotation in year 29. For economic purposes the rotation length was thirty years (year 0 included). Timber value for ages 11 and 29 were calculated using 1995 3rd quarter stumpage values published by the Louisiana Department of Agriculture and Forestry and no premium was given to the pruned trees. A further assumption was that the land was sold in year 29, after the timber harvest, for \$300 per acre. Actual cost data were used in the computation of costs for the alternatives in which pre-commercial and commercial thins, and pruning occurred.

RESULTS

Plantation Growth

Since treatment combinations were replicated only two times, all age 29 plantation growth data are presented in tabular form without statistical inference. Age 11 merchantable volumes for the unthinned 8 x 8 and 10 x 10 planting densities were similar, averaging 1,700 ft³/acre, while age 6 PCT and pruning treatment volumes averaged 1,530 ft³/acre. The mean age 11 harvest volume for the age 6 PCT and pruning treatments thinned to 100 TPA was 1,050 ft³/acre. Age 29 growth attributes varied among treatments combinations (Table 2). Standing merchantable volume varied among treatments with check, PCT, PRN, and PCT x PRN treatments averaging 4,540, 3,260, 2,560, and 3,420 ft³/acre, respectively. Total merchantable volume yield (standing volume + age 11 thinned volume) for PCT, PRN, and PCT x PRN treatments were 230, 930, and 70 ft³/acre less than the unthinned treatments. Although plantation growth data were not evaluated statistically, tabular results are consistent with previous research performed at other locations. In South Africa, 9-year-old loblolly pine merchantable volume yields at 400 and 600 TPA on site index of 98 were similar averaging 1,760 ft³/acre (Craib, 1947). Clason (1994) reported loblolly pine age 21 merchantable volume differential between 300 and 600 TPA was 60 ft³/acre on a site index of 65.

Study treatments altered pine distribution within DBH-size classes (Table 3). Pine DBH distribution differed among treatments in both chip-n-saw (5.6 to 9.5 inches) and sawtimber (> 9.6 inches) wood product size classes. The unthinned 8 X 8-foot planting density treatment had significantly fewer pines in the sawtimber size class than any of the lower stocking densities. Although the unthinned 10 x 10-foot planting density had 206 trees in the sawtimber size class, the modal diameter range was 9.6 to 11.5 inches. In contrast, the modal ranges for the PCT, PRN, and PCT x PRN treatments were 13.6 to 16.5 inches, 12.6 to 16.5 inches, and 14.6 to 17.5 inches.

DBH-size class distribution differentials impacted treatment product volume distribution (Table 4). Although check treatments had 3 to 5 times more trees, lumber volume was less than all other age 6 treatments. Check 10 x 10-foot lumber volume exceeded the 8 x 8-foot volume by 4,400 BDF/acre. PCT, PRN, and PCT x PRN treatment lumber volumes exceeded the 10 x 10 foot volume by 4,420, 1,430, and 5,630 board feet (Doyle)/acre, and clearwood lumber yields were 30 times greater. Average clearwood recovery rate for check, PCT, PRN, and PCT x PRN treatments averaged 2.4, 14.4, 28.8 and 24.3 percent, respectively. Thus, stocking density adjustments and pruning at ages 6 and 11 enhanced plantation development by accumulating merchantable volume growth in the sawtimber product size class.

Financial Impact

Economic comparisons of the planting density, thinning, and pruning alternatives are provided in Table 5. Alternatives are labeled “A” through “H”. Future values of costs and revenues and net future value of the various alternatives are presented in columns d, e, and f. A future value assumes that payments made or received could have been immediately invested in an alternative at a minimum acceptable rate of return. It therefore accounts for the opportunity cost of capital. The equation used in columns d, e, and f was:

$$1) \quad V_n = V_o(1+i)^n$$

where V_n is the future value of a single amount,
 V_o is the original cash outlay or receipt,
 i is the interest rate,
and n is the rotation length (Klemperer 1996).

For this analysis, the interest rate was assumed to be 8%. The rotation length was thirty years, since the analysis began in year 0 with the purchase of land and site preparation activities. All costs and revenues were assumed to occur at year's end. Column d of Table 5 provides a cost comparison between the alternatives in terms of capitalized values, while column e compares revenues. Alternative G yielded the highest compounded value costs, while Alternative B was the least costly. The greatest compounded revenue (Table 5, column e) was generated from Alternative H, while Alternative A yielded the least revenues. Net future values, or the sums of capitalized revenues less the sums of capitalized costs for each alternative, are presented in column f. Net present values (NPV), or the sums of discounted revenues less the sums of discounted costs for each alternative, are presented in column g. Net future value and NPV are actually two sides of the same coin, since NPV can be thought of as the net future value discounted to the initial period. The NPV ranged from a low of -\$47.70 per acre for Alternative E to a high of \$254.76 per acre for Alternative H.

Land expectation values (LEV's) were calculated using the Faustmann formula (Klemperer, 1996), which takes the following form:

$$2) \quad LEV = \frac{\sum_{y=0}^{t-1} R_y(1+i)^{t-y} - \sum_{y=0}^{t-1} C_y(1+i)^{t-y}}{(1+i)^t - 1} + \frac{a - c}{i}$$

where R_y is equal to periodic or one-time revenues,
 C_y is equal to periodic or one-time costs,
 t is the rotation length,
 y is the year in which the cost or revenue occurs,
 i is the opportunity interest rate,
 a is equal to annual revenues, and
 c is equal to annual costs.

Since the land expectation value equation provides an estimate of the willingness to pay for bare land, the assumed cost and revenue from land purchase and sale were excluded from the calculation. Land expectation value then becomes a simple calculation of discounted revenues less discounted costs (or NPV) evaluated on a perpetual basis. These calculations are presented in column h of Table 5. Results indicate that Alternative H generated the highest LEV (\$524.93 per acre), while Alternative E generated the lowest LEV (\$226.29 per acre). The internal rate of return (IRR) was computed using a Microsoft Excel® spreadsheet function, and is presented in column j of Table 5. Alternative H generated the highest IRR (9.98%). Alternative E generated the lowest IRR (7.59%).

CONCLUSION

The goal of this paper was to present data collected from a study in which silvicultural treatments of thinning and one-and two-lift pruning schedules were evaluated for their effects on sawtimber production and quality, and plantation value in a 29-year-old loblolly plantation.

From a management perspective, stocking density adjustments at ages 6 and 11 enhanced plantation development by accumulating merchantable volume growth in the sawtimber product size class. The data further indicate that Alternative H, which combines a 10 x 10 foot planting density an age 6 pre-commercial thin, an age 11 commercial thin, and pruning treatments at age 6 and 11, was the economically superior alternative. In general, the thinning and pruning silvicultural treatments were superior to check treatments, regardless of spacing. The exception was Alternative E, which combines a 8 x 8 spacing with a thin at age 11 and pruning treatments conducted at ages 6 and 11. Alternative E had relatively high costs and relatively low revenues. It also had the highest per unit costs. This led to low NPV, LEV, and IRR values. From this data, it appears that pre-commercially thinning and pruning used in conjunction with other silvicultural prescriptions such as heavy commercial thinning (in this case, at age 11) can yield superior investment returns for forestland managers and investors. These values could, of course, vary subject to changes in other factors, such as the relative prices for forest products, interest rates, site characteristics, genetic properties of trees, or other marketing factors.

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Table 1. Treatment costs and revenues

Table 1. Treatment costs and revenues									
Treatments ^a	Costs					Revenue:			
	Seedlings	Planting	Harvest ^b			Pruning		Harvest ^b	
			PCT	CT	FH	Age 6	Age 11	Age 11	CT
			Age 6	Age 11	Age 29	9 Feet	9 Feet	18 Feet	Age 11
	-----Dollars/Acre-----								
A	23.12	40.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	14.79	25.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	23.12	40.12	40.82	16.00	0.00	0.00	0.00	306.00	766.97
D	14.79	25.66	40.82	16.00	0.00	0.00	0.00	306.00	793.20
E	23.12	40.12	0.00	16.00	0.00	153.00	153.00	0.00	589.74
F	14.79	25.66	0.00	16.00	0.00	153.00	153.00	0.00	744.95
G	23.12	40.12	40.82	16.00	0.00	153.00	153.00	0.00	731.87
H	14.79	25.66	40.82	16.00	0.00	153.00	153.00	0.00	814.43

Table 1 continued. Treatment costs and revenues

a A = unthinned 8 x 8; B = unthinned 10 x 10; C = PCT, once pruned 8 x 8; D = PCT, once pruned 10 x 10; E = No PCT, twice pruned 8 x 8; F = No PCT, twice pruned 10 x 10; G = PCT, twice pruned 8 x 8; H = PCT, twice pruned 10 x 10.

b PCT = Pre-commercial thin

CT = Commercial thin

FH = Final Harvest

Table 2. Age 29 growth data attributes by pruning treatment

Pruning Treatment	Stand Density	DBH	Height	Basal Area	Merchantable Volume
	Trees/Acre	Inches	Feet	Ft ² /Acre	Ft ³
A	480	8.9	64	207	4,520
B	323	10.5	77	194	4,565
C	101	14.9	69	121	3,175
D	101	15.2	78	127	3,315
E	85	14.1	74	93	2,400
F	86	14.9	77	105	2,710
G	101	15.2	73	127	3,280
H	98	16.1	77	138	3,550

aA = unthinned 8 x 8; B = unthinned 10 x 10; C = PCT once pruned 8 x 8; D = PCT once pruned 10 x 10; E = No PCT twice pruned 8

x 8; F = No PCT twice pruned 10 x 10; G = PCT twice pruned 8 x 8; H = PCT twice pruned 10 x 10.

Table 3. Age 29 DBH-size class distribution by pruning treatment

D-Class	Pruning Treatments							
	A	B	C	D	E	F	G	H
Inches	-----Trees/Acre-----							
4.6-5.5	5	—	—	—	—	—	—	---
5.6-6.5	25	1	---	---	---	---	---	---
6.6-7.5	81	10	---	---	---	---	---	---
7.5-8.5	113	31	---	---	---	---	---	---
8.6-9.5	114	52	---	---	---	---	---	---
9.6-10.5	87	64	1	---	3	1	---	---
10.6-11.5	40	65	3	3	5	3	3	---
11.6-12.5	5	49	8	6	10	6	6	2
12.6-13.5	---	24	13	12	17	12	12	5
13.6-14.5	---	4	21	18	19	17	19	11
14.6-15.5	---	---	23	22	18	19	23	17
Table 3 continued. Age 29 DBH-size class distribution by pruning treatment								
15.6-16.5	---	---	20	21	10	16	21	23
16.6-17.5	---	---	10	13	3	10	13	22
17.6-18.5	---	---	2	6	---	2	4	14
18.6-19.5	---	---	---	---	---	---	---	4
19.6-20.5	---	---	---	---	---	---	---	---
Total	480	323	101	101	85	86	101	98

aA = unthinned 8 x 8; B = unthinned 10 x 10; C = PCT once pruned 8 x 8; D = PCT once pruned 10 x 10; E = No PCT twice pruned 8 x 8; F = No PCT twice pruned 10 x 10; G = PCT twice pruned 8 x 8; H = PCT twice pruned 10 x 10.

Table 4. Age 29 product volume growth by pruning treatment

Product Volume						
Treatment	Pulpwood	Sawtimber			Lumber	
		Chip-N-Saw	Total	Clear	Total	Clear
	-----Ft3/Acre-----				-----BDF/Acre-----	
A	485	3,070	965	30	2,510	30
B	235	2,000	2,330	50	6,970	55
C	55	395	2,725	400	10,940	1,620
D	50	375	2,890	420	11,830	1,700
E	45	370	1,985	570	7,580	2,140
F	45	335	2,330	670	9,370	2,720
G	50	380	2,850	690	11,600	2,880
H	50	330	3,170	770	13,600	3,260

aA = unthinned 8 x 8; B = unthinned 10 x 10; C = PCT once pruned 8 x 8; D = PCT once pruned 10 x 10;

E = No PCT twice pruned 8 x 8; F = No PCT twice pruned 10 x 10; G = PCT twice pruned 8 x 8; H = PCT twice pruned 10 x 10.

Table 5. Financial comparison by planting density, pruning treatment, and thinning treatment for a 30-year rotation.

Treat- menta	Thin Option (a)	Prune Option (b)	Planting Density (c)	F.V. Costs (d)	F.V. Revenues (e)	Net Future Value (f)	NPV (g)	LEV (h)
TPA -----Dollars/Acre-----								
A	None	None	680	4,642.75	4,385.38	(259.37)	(27.84)	246.
B	None	None	435	4,430.50	4,864.75	434.25	46.61	323.
C	age 6 & 11	age 11	680	6,169.14	7,719.43	1,550.29	166.69	446.
D	age 6 & 11	age 11	435	5,956.89	8,128.42	2,171.53	233.07	514.
E	age 11	age 6 & 11	680	6,216.41	5,772.00	(444.40)	(47.70)	226.
F	age 11	age 6 & 11	435	6,004.16	7,004.28	1,000.12	107.34	385.
G	age 6 & 11	age 6 & 11	680	6,456.08	7,804.74	1,348.66	144.75	424.
H	age 6 & 11	age 6 & 11	435	6,241.95	8,804.78	2,562.83	254.76	524.

aA = unthinned 8 x 8; B = unthinned 10 x 10; C = PCT once pruned 8 x 8; D = PCT once pruned 10 x 10; E = No PCT twice pruned

8 x 8; F = No PCT twice pruned 10 x 10; G = PCT twice pruned 8 x 8; H = PCT twice pruned 10 x 10.

The Effect of Relative Product Prices on the Optimal Management of Loblolly¹ Pine

James E. Henderson² and Ian A. Munn³

Abstract. Product prices may indicate the appropriate management regime when the landowners' primary objective is to maximize value through timber revenues. The effect of relative product prices (pulpwood and sawtimber) on the financially optimal management regime for loblolly pine (*P. taeda*) plantations was examined across a range of site indices, discount rates, and initial planting densities. Planting densities of 538 and 681 trees per acre (TPA) were included. Management scenarios included in the analysis involved sawtimber rotations (one or more thinnings) and pulpwood rotations (no thinning). Relative product prices were defined by expressing the price of pulpwood as a percentage of sawtimber price. Pulpwood rotations are not optimal at current prices. Pulpwood would have to be 44 to 84 percent of sawtimber value depending on site index and discount rate before pulpwood rotations would become optimal. This required price of pulpwood decreases with decreasing site indices and increasing discount rates. This holds true except in the case of extremely high site indices such as SI 90 and 80 (base age 25), where the required price of pulpwood rises with increasing discount rates. At current prices, LEV's are greater for planting densities of 538 TPA than planting densities of 681 TPA.

Key Words: optimal rotation, optimal management regime, relative product prices

INTRODUCTION

The profit maximizing management regime for loblolly pine depends, in part, on the relative price of pulpwood and sawtimber. For example, if the desired end product were pulpwood then a regime that maximizes pulpwood production would be applied. In contrast, if the desired end product were sawtimber then a regime that maximizes sawtimber production would be followed. If the landowners' objective is to maximize profits, optimal management regimes may well depend on relative product prices. This study sought to determine how relative product prices impact the selection of the optimal management regime for loblolly pine plantations. The effects of product price on two types of management regimes (pulpwood and sawtimber) are investigated. Pulpwood regimes are defined as management regimes that do not include thinnings and are characterized by high initial stocking. Sawtimber regimes are defined by one or more thinnings and are characterized by a lower initial stocking. For each combination of site index, planting density, and interest rate there is a combination of relative product prices at which landowners should be indifferent between sawtimber and pulpwood rotations.

¹Approved for publication as Journal Article No. FO-(239) of the Forest and Wildlife Research Center (FWRC), Mississippi State University. We thank S. H. Bullard and R. D. Daniels for constructive manuscript reviews.

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METHODOLOGY

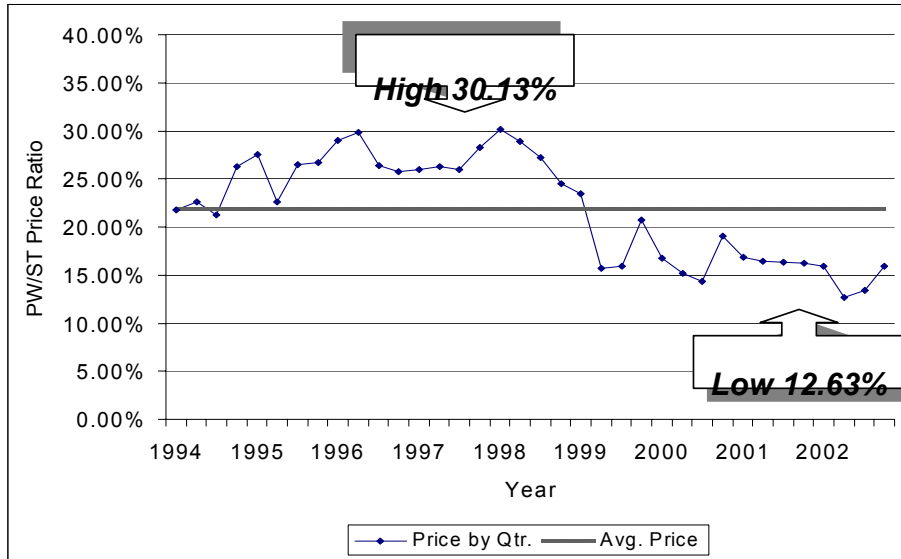
Growth and yield were projected for three management alternatives: no thinning, one thinning, and two thinnings using P-Yield (Hafley and Smith 1989). Land expectation values (LEV) were computed for all projections. Initial stand conditions included a range of site indices and two planting densities. Site indices include SI 50 through 90 base age 25, which are representative of those found in Mississippi. Two initial planting densities of 681 trees per acre and 538 trees per acre were considered. These two planting densities are used to characterize pulpwood and sawtimber regimes respectively as pulpwood rotations are characterized by higher planting densities and sawtimber rotations are characterized by lower densities (Smith et al. 1997). Survival after five years was assumed to be 80%.

End products were limited to pulpwood and sawtimber. Product specifications were eight inches small end diameter inside bark for sawtimber and four inches for pulpwood. Harvest volumes were expressed in tons to simplify comparison of product prices. Thinning ages were determined by Stand Density Index (SDI). The SDI was computed for each age, site index, and planting density using Reineke's (1933) formula for loblolly pine. When the SDI reached 55% of the maximum 450 for loblolly pine, the SDI was reduced to 35% using a low thinning. These upper and lower boundaries are consistent with profit maximizing objectives (Dean and Chang 2002). For each SI and planting density, thinning ages and amounts were held constant for all projections.

Relative product prices rather than absolute prices were used. The stumpage price of sawtimber was set equal to one and pulpwood price was expressed as a percentage of sawtimber price. For analysis purposes, pulpwood price was allowed to vary, reflecting the price variations that have occurred in Mississippi from 1994 to 2003. (See Figure 1.) A range of pulpwood prices was considered that included the high of 30.13% and the low of 12.63%.

Establishment costs were based on South-wide averages for 2000 reported by Dubois et al. (2001). Site preparation costs included chemical treatment and burning. Planting costs were \$0.069 per seedling. Thus, the total cost of stand establishment was \$129.36 for 681 trees per acre and \$119.36 for 538 trees per acre. These costs were expressed as a percentage of the sawtimber price in Mississippi for 2000, since LEV's are based on relative rather than absolute prices.

Figure 1. Stumpage Pulpwood Price as Percentage of Sawtimber Price (1994-2002, MS)



Harvest volumes were projected over a range of rotation ages for each combination of site index and planting density for both product regimes. The range differed for each site index and interest rate, yet was large enough to capture the maximum Land Expectation Value (LEV). Thinning ages were held constant for each combination of SI and planting density, but the final harvest age varied as indicated by LEV. The rotations ages that maximized LEV for pulpwood and sawtimber regimes (i.e., no thinning versus thinning) were determined for each combination of site index, planting density, discount rate, and price.

The optimal rotation age was identified for each management regime. The regime with the highest LEV at its optimal rotation age was identified as the optimal product regime. First, historic prices were used to identify the optimal product regimes for prices likely to occur. Next, prices were varied until the price at which profit-maximizing landowners would be indifferent between sawtimber and pulpwood regimes was identified. Table 1 includes a listing of all financial and biological factors that were allowed to vary.

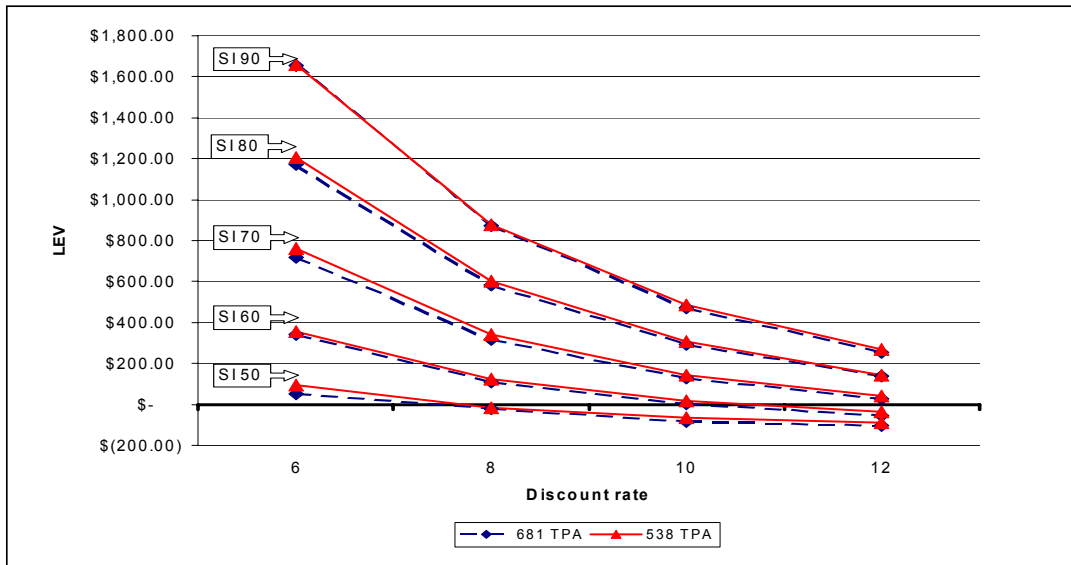
Table 1. Variable biological and financial factors included in growth projections and LEV calculations.

Site Indices	50, 60, 70 ,80, 90 (base age25)
Planting Density (TPA)	681 (9x9), 538 (8x8)
Harvest Age	Variable range
Discount Rate (%)	6, 8, 10, 12
Relative Price Ratio	12.63% to 30.13%

RESULTS

For relative pulpwood prices below 30.13%, the ten-year high for pulpwood in Mississippi, sawtimber rotations are financially optimal for all combinations of site index, planting density, and discount rate. LEV's at the mean price ratio ranged from \$1,660 for SI 90 at a 6% discount rate to -\$90 for SI 50 at a 12% discount (Figure 1).

Figure 1. LEV's at Mean Pulpwood Price Ratio of 21.90 Percent



the value of pulpwood is 67% of sawtimber value.

Figure 2. Price Indifference Point between PW and ST Rotations – 681 TPA

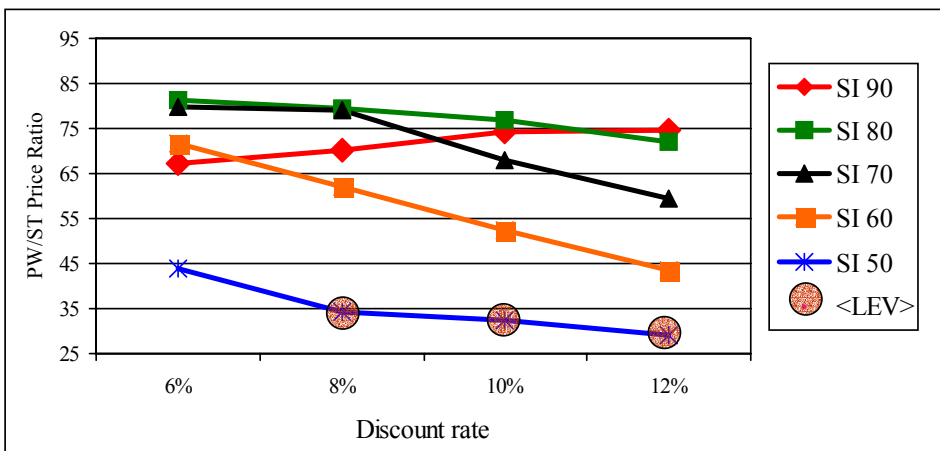
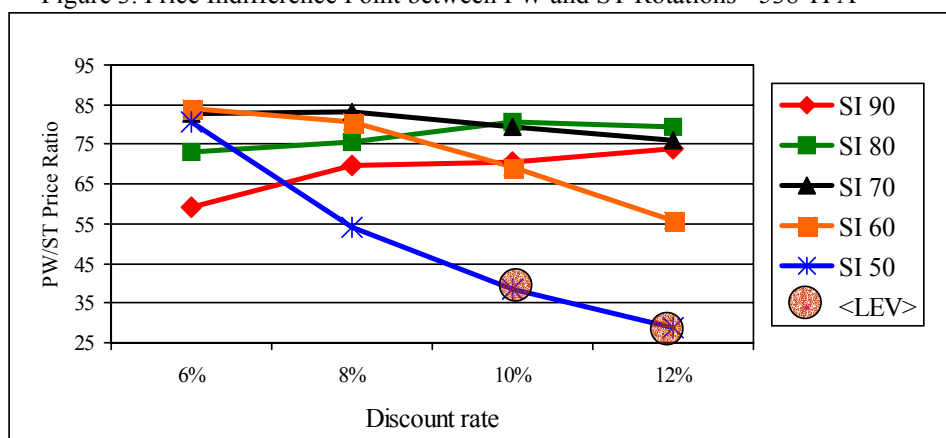
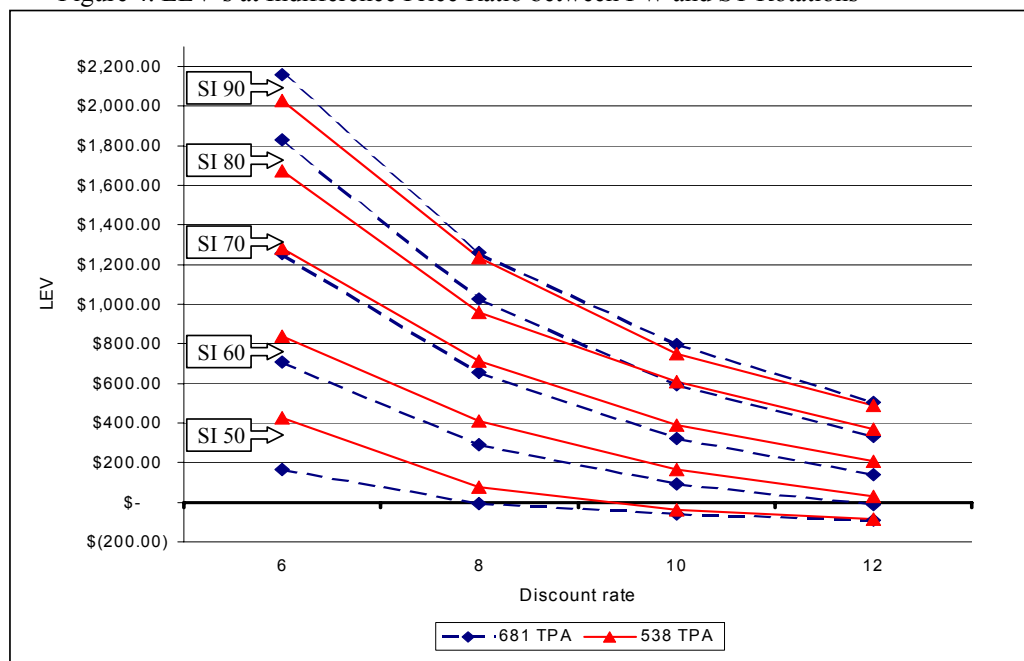


Figure 3. Price Indifference Point between PW and ST Rotations - 538 TPA



LEV's for 538 TPA were greater than 681 TPA over the range of historic prices for all site indices and discount rates considered. This trend was also observed at the indifference price between pulpwood and sawtimber rotations for SI 50, 60, and 70. LEV's at the indifference price ratio for SI 80 and 90 were greater for 681 TPA (Figure 4).

Figure 4. LEV's at Indifference Price Ratio between PW and ST Rotations



DISCUSSION

The indifference price changes with the discount rate. How the indifference price changes depends on site index. For better site indices such as SI 90 and 80, the indifference price ratio increases as discount rates increase. For SI 50, 60, and 70, the price ratio decreases with increasing discount rates. The trends are driven by the relative amount of sawtimber. As the discount rate increases, the optimal rotation age decreases. At lower rotation ages, lower site indices have proportionately less sawtimber volume relative to pulpwood volume. Thus the pulpwood price relative to sawtimber price necessary to make pulpwood regimes optimal does not have to be as high. The better site indices produce a greater proportion of sawtimber earlier in the rotation so higher pulpwood prices are necessary for pulpwood rotations to be optimal compared to lower site indices.

SUMMARY

Sawtimber rotations are optimal at current product prices. Pulpwood rotations are optimal only when pulpwood prices as a percentage of sawtimber prices are extremely high, anywhere from 44 to 84% of sawtimber prices depending on site index and the minimum acceptable rate of return. The indifference price between pulpwood and sawtimber regimes decreases with decreasing site indices and increasing discount rates, except for those involving extremely high site indices. The indifference price ratio increases with increasing discount rates for the better site indices such as SI 90 and 80. At current prices, planting densities of 538 TPA result in greater LEV's than planting densities of 681 TPA.

Considerations for future research include the addition of chip-n-saw, price adjustments for quality, e.g. lower prices for first thinning pulpwood and higher prices for larger diameter sawlogs should be addressed.

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Computer Simulation Model for Assessing Wood Procurement Practices in the Southeastern United States

William H. Howell and Michael L. Clutter

Throughout the Southeastern United States there exists a plethora of wood procurement strategies/systems that provide wood using facilities with raw materials. These systems attempt to balance the raw materials costs and procurement risks of consistent raw materials furnish. It is generally recognized that different procurement strategies have different levels of risk and costs associated with them.

Our study will model, through use of Monte-Carlo simulation techniques, three commonly utilized procurement strategies in the South. The procurement strategies will be modeled on a weekly basis, with the three strategies being the allocation of production evenly among suppliers, production allocated based on estimated fixed costs of suppliers, and production allocated based on the average weekly production of suppliers. To accurately portray these systems, we used data from the recently completed Greene et al (2002) study, which provided 3,132 weekly production reports during 2000 and 2001 from 63 logging crews and 8,212 weekly mill usage and inventory reports during 2000 and 2001 from 130 mills, along with station specific daily rainfall data from the United States Geological Service for 1897-2000. Through the use of financial software programs (@Risk and Risk Optimizer), we attempted to incorporate the inherent risk included in many of the variables in wood procurement systems.

This model will attempt to identify optimal levels of logging force, mill woodyard inventory, and procurement strategy. We will present a wood procurement simulation model that is mill specific, can evaluate current wood procurement practices and identify possible changes that will reduce cost and/or risk associated with the wood procurement system.

Examining the Performance of Independent Harvesting Firms in the Eastern United States¹

Brian D. Jackson², William B. Stuart, Laura A. Grace, and Andrew J. Londo

Abstract: Thirty-eight harvesting firms provided business information, production and expense data for a comprehensive analysis of trends affecting the logging businesses. Contractors are leaving the industry; the study began with 50 participants but 12 withdrew from the industry between 1998 and 2001. The younger entrepreneurs left and in 2002 the median age was 51½. Equipment was also aging. In-woods, production equipment had median ages of at least five years, haul trucks tended to be older (median age of seven years). Corporations were the most common business forms; 78% in 2002, versus 59% in 1995. The analyses provided evidence that equipment investment has dropped; equipment costs declined from 22.3% of total cost in 1999 to 18.9% in 2001. The cost of labor increased 5%. The unadjusted average cost per ton for the population increased from 2000 (\$13.40) to 2001 (\$14.74).

Key Words: Logging, Cost Analysis, Production Analysis

Funding provided by

Mississippi State University, Department of Forestry and the USDA Wood Utilization Research Grant

INTRODUCTION

Independent harvesting firms are a critical link in the wood supply system of the eastern United States. The wood supply system is a network consisting of three major stakeholders in the production of forestry: landowners, logging firms, and the forest products manufacturing firms (Stuart and Grace 1998). Without loggers, the system would not exist. They convert the landowner's potential wealth of timber crops into actual wealth – a salable market commodity. Loggers harvest one of the most economically viable natural resources available, and make the forest products industry one of the largest manufacturing industries in the nation (Anon. 1995). Logging constitutes a considerable portion of the cost of converting standing timber into useable forms (Brown 1949). The status and structure of logging businesses and their general financial well-being are important to the overall status, health, and viability of the forest industry, warranting a comprehensive study to determine business' performance.

This study examined the productivity and expense patterns of independent logging businesses and related them to business performance. Many factors will affect the success or failure of a logging business: weather conditions, business cycles, compliance with environmental regulations, downtime due to equipment breakdowns, market fluctuation, and mill quotas, to name a few. These factors can limit production capacity while increasing total cost.

STUDY OBJECTIVES

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Cost and productivity studies are useful in determining the overall status of the wood producing and consuming industry. Traditional studies have been restricted to short term analyses incorporating assumptions concerning machine life, operating costs, and market and weather stability. Few have monitored actual expenditures and production over periods of weeks, months, or years. Fewer have focused on a group of firms dispersed across a wide geographical region.

The overall project objective was to assess the long term business performance of independent logging firms in the eastern United States. Specific objectives for this study included:

- 1) Maintain and expand the database of contractor cost and production information.
- 2) To document business characteristics and shifts of participating firms throughout this study period as well as relating these to previous cost and productivity studies.
- 3) To monitor the productivity, expense, and production cost (cost per ton) shifts that occurred during the study period and how these factors affected business performance.

RESULTS

Methods and Procedures

Selection and Participation

This study builds on a body of research first documented by Loving (1991). Potential participants were nominated by various organizations, such as the Forest Resource Association (FRA), state loggers' associations, Certified Public Accountants (CPA), and wood-consuming firms. Those nominated were expected to be respected business professionals in their geographic area and were also expected to be in compliance with relevant laws and regulations, including workers' compensation insurance. Detailed financial records were required in order to capture the necessary information.

Participation in the study was strictly voluntary. Firms have been added and have left over the course of the study, depending on their continuation in the industry, willingness to participate, or their ability to provide cost and production information.

Typically, when a contractor is nominated or asks to be included in the study, an initial meeting is scheduled to discuss the nature of the project and the purpose of the research. The objectives of the study are explained. They are informed of the voluntary nature of participation and the efforts made to ensure confidentiality in the collection and treatment of their data. The potential participants are told about the type of data that is requested, procedures used to ensure the confidentiality of the data, and how the data will be used. Potential participants are also provided examples of recent research outputs. Nominees are asked to consider participating in the project at the end of this initial meeting. Potential participants are contacted later and, if they choose to participate, a second meeting is scheduled to initiate data collection.

Data Acquisition

Initial data concerning business characteristics and structure were collected during the second meeting. These meetings were usually performed at the contractors' job site, home, or office. Production and cost data collection were also discussed to determine the most convenient method for the firm submitting the data. Often, this entailed scheduling subsequent visits with the contractor, contractor's bookkeeper, or CPA. Some contractors requested that the

researchers contact their CPA or wood purchasers directly. Regardless of the method of data transfer, each participating contractor was visited at least annually, and periodic reports were sent to the contractor to provide project updates. Follow-up contact was maintained by mailing reports and regular phone conversations.

Contractor and Business Characteristics

Forty-two firms provided data concerning their business characteristics. The criteria for inclusion favored good, dependable, well managed businesses. The firms selected were considered to be in the upper tier of their profession and were well respected in their area. They differed in equipment spread, business characteristics, entrepreneur's age and education, along with many other characteristics.

The 42 firms were located in thirteen eastern states, encompassing four major physiographic regions: the coastal plain (20), Piedmont (13), Lake States (4), and the Appalachians (5). The majority (48%) of the firms were located in the coastal plain region, while the Piedmont region added another 31 percent.

The firms in the study were primarily owned or managed by white males between the ages of 35 and 70, with a median age of 51.5. Many wives and mothers were also active business participants, involved in the decision making process for the business, and active in the record keeping and business office of the firm. Others were silent partners in the ownership.

Owning and operating a capital intensive business such as logging requires the manager to be both educated and a savvy businessman in order to be successful. The highest level of education achieved by the participants, along with other formal training is shown in Figure 1.

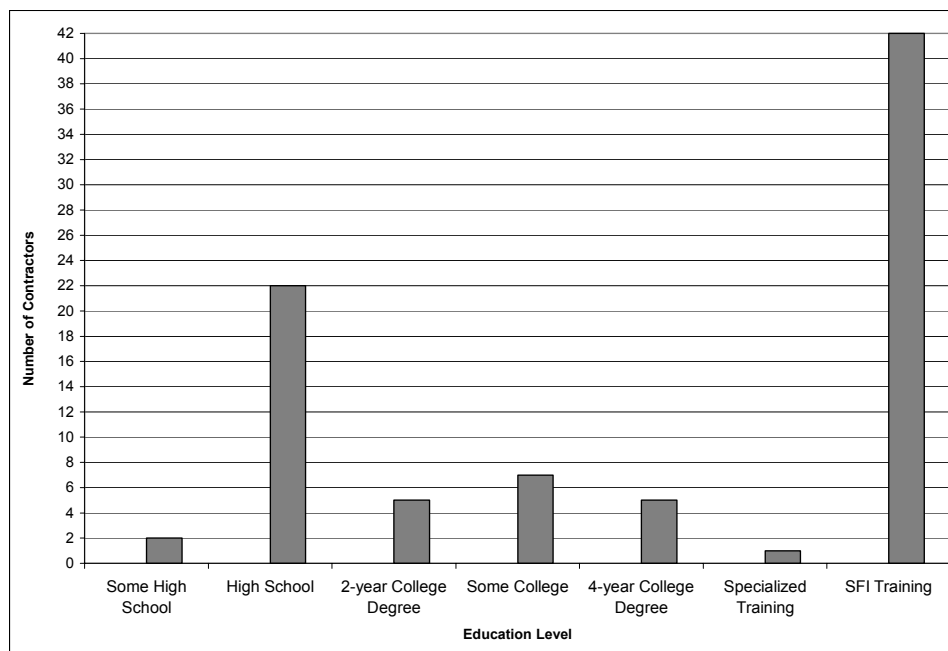


Figure 1 Highest level of education attained by study participants.

Only two contractors had not completed high school, over 95% had high school diplomas, and fifty-two percent had high school completion as their terminal, formal education. Forty-three percent had attended at least some college. One contractor had specialized training in lumber grading. All had completed formal SFI training.

Four common organizational structures were observed; C corporations, S corporations, sole proprietorships, and Limited Liability Companies (LLCs). These business structures were plotted with each firms' estimate of their annual production to compare potential relationships of business size to organizational structure (Figure 2).

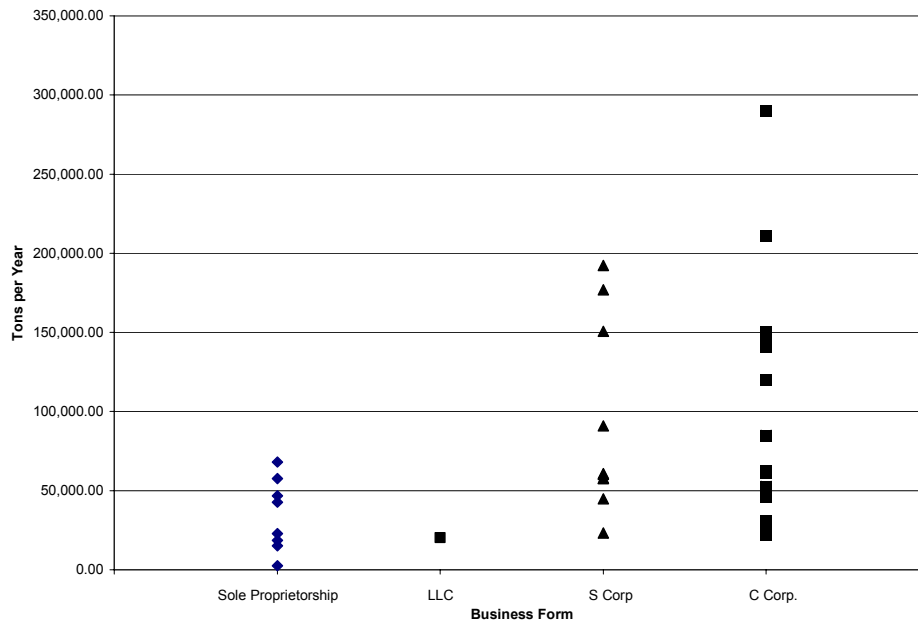


Figure 2 Business structure versus production size of participating logging firms in 2002.

The majority of the firms were corporations. Nineteen (45%), were C corporations, fourteen (33%) were S corporations, eight (19%) were sole proprietors, and only one firm (3%) was a limited liability company (LLC). Sole proprietorships were usually smaller firms. However, not all small firms (in terms of estimated production) were sole proprietorships. Several of the smaller firms had incorporated. No firm with an estimated annual production in excess of 100,000 tons was a sole proprietorship. Incorporation, either as an S or C corporation, was common across all business sizes. Accountants and financial advisors often suggest to their clients that it would be in their best interest to incorporate, to protect personal assets and for tax purposes.

Aging trends for each equipment type became more apparent in this study when compared with similar data from 1998 (Table 1).

Table 1 Median equipment ages (years) for the 1998 and 2002 studies.

Equipment Type	1998	2002
Feller-bunchers	2	5
Skidders	3	6
Loaders	3	5
Trucks	4	7
Service Vehicles	3	6
Bulldozers	11	9

Comparing the current (2002) equipment age with the equipment ages in 1998 finds median equipment ages have increased for every category except for bulldozers. The median age of feller-bunchers, skidders, trucks, and service vehicles increased three years over the four-year period, implying limited renewal of production equipment.

A Kolmogorov-Smirnov Two – Sample Statistic Test was also used to test the assumption that equipment age distributions have changed since 1998. This is a general, two sample test that is useful for comparing two independent and random samples of similar size (Daniel 1990), in this case the similarity between equipment age distributions from 1998 and 2002.

The null and alternative hypotheses were:

H₀: Age₁₉₉₈ = Age₂₀₀₂

H_A: Age₁₉₉₈ ≠ Age₂₀₀₂

Table 2. Probabilities (significance values) for each equipment type (1998, 2002), showing the differences in age distributions, calculated using the Kolmogorov – Smirnov Two Sample Test.

Equipment Type	Probability
Feller-bunchers	0.01 > p > 0.005
Skidders	0.1 > p > 0.05
Loaders	0.1 > p > 0.05
Trucks	0.1 > p > 0.05
Service Vehicles	0.1 > p > 0.05
Bulldozers	0.2 > p > 0.1

The probabilities for tests of each of the equipment types in Table 2 demonstrate that the distributions have changed in shape or location. The tests indicated that the age distributions of each equipment type, except bulldozers, have changed in the past several years. The highest significance values were for the feller-bunchers (>0.01), followed by skidders, loaders, trucks, and service vehicles (0.1). The difference in bulldozer distributions was not statistically significant using scientific thresholds of significance, but there appears to be a practical difference; in actuality, several decades-old machines were replaced.

Equipment purchases have declined over the last several years. Several explanations exist for this trend: first, operating mergers left little room for reinvestment, financing was difficult to arrange, and insurance companies were not willing to risk insuring expensive machinery. The market for used equipment declined in the late 1990s and many could replace older equipment with newer, but used machines. During the early and mid 1990s, contractors rotated machines every three to four years. Very few firms in this study have been able to do so in recent years. Many were encouraged by dealers or company foresters to run older equipment under the assumption that it would reduce costs and lead to profitability. In fact, the use of older equipment decreases equity of the firm, results in higher taxes, and increases repair and maintenance costs. Production capability is also affected by unpredictable downtime. New equipment purchases, for the most part, were only made when absolutely necessary.

Cost and Production Analysis

Thirty-five firms provided cost and production data for 1997 thru 2001. The expenditures were segregated into six categories: equipment, consumables, labor, insurance, contract services and administrative overheads. The median percentage contribution of each of these to total cost is shown in Table 3.

Table 3 Median percentages of expense components for 35 logging firms from 1997 to 2001.

	Equipment	Consumables	Total Labor	Insurance	Contract Services	Overheads
1997	20.89%	19.82%	30.56%	3.24%	15.75%	2.26%
1998	19.59%	18.15%	32.98%	3.16%	12.97%	3.17%
1999	22.32%	19.35%	33.64%	3.09%	14.16%	3.23%
2000	19.19%	20.68%	32.98%	3.36%	13.56%	2.71%
2001	18.86%	19.60%	35.55%	3.62%	18.32%	2.82%

Labor expenditures were the largest contributor to total cost for the sample population and the percentage has increased from 1997 (30.56%) to 2001 (35.55%). Equipment expenditures rose in 1999, fell back and ended at a period low (18.86%). The pattern for contracted services was particularly interesting; falling, rising, and ending the period approaching equipment expenditures. Increased contract services costs indicate that the firms have opted to outsource a greater portion of their services to others. Insurance costs have increased from 3.09% in 1999 to 3.62% in 2001. Overhead costs spiked in 1999 but dropped to one of its lowest levels in 2001, another possible sign of cost-cutting in areas unrelated to the business' direct operation. Administrative costs seemed to be the only manageable or controllable expenditures over the period.

Consumable supplies fell in 1998, then rose with increased fuel prices in 2000 to the point they displaced equipment as the second largest cost category. Higher repair and maintenance expenses from operating older equipment also contributed to the rise. Increased fuel prices were a major reason for the spike in consumable supplies expenditures for 2000.

Cost per ton is a function of the relationship between production and expenditures, but that relationship is not necessarily mechanical or predictable. In essence, a high or low cost per ton value does not necessarily equate with a firm's operational efficiency. It may reflect investment strategy, market access, weather, quota, or other factors. Figure 3 shows the

correlation between total annual cost and annual production for the years 1999 to 2001. Linear trend lines were fitted for each year's data. The R^2 -values were relatively high for these comparisons. These regression analyses are not intended as prediction equations but rather as descriptions of how costs changed from year to year. They also indicate that the often supposed economies of scale do not really exist in logging.

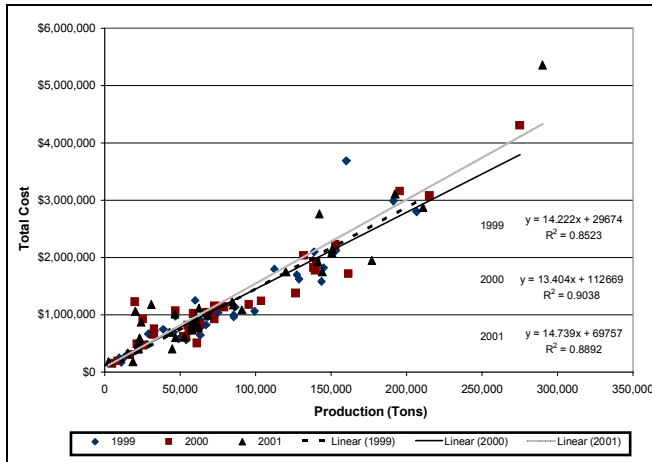


Figure 3 Unadjusted total cost versus annual production for 38 logging firms from 1999 to 2001.

The cost of adding one more ton of production is indicated by the slope of the line. The y-intercepts describe the amount of fixed costs or investments. Fixed costs, in this case, are those unaffected by production or relatively unchangeable from year to year, for a particular firm (Stuart and Grace 1998). The cost of producing one more ton increased from \$14.22 in 1999 to \$14.74 in 2001, an approximate five percent increase; it was, however at a period low in 2000 at \$13.40. The intercept was the highest in 2000, which indicated an increase in “fixed” costs for the firms. Industry/market instability during that year may have contributed. Total production amount explained 85 to 90% of the variation in total cost for the three years.

CONCLUSION

Independent harvesting contractors have struggled financially in recent years. Many have assumed that the answer to the problem is increasing production. This is not always the best remedy. Each firm reacts differently to the changing market conditions and will find ways of adapting. Strategies that work well for some contractors may not work well for others. The wood supply system is a complex, social, and economic construct that does not react to external stimuli in the same manner as a biological system. The system is not easily corrected when disturbed and the effects of attempts to “correct” it are not predictable.

The industry was in a state of unrest during 1999 and 2000, mainly due to corporate mergers, which changed markets. However, a settling down period seemed to occur in 2001, when the system began to react and adapt to the changes. Further insight will continue to be gained with the collection of actual expense and production data from logging firms and additional analyses of their business investment.

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A Discussion of Antitrust Implications for Future Horizontal Merger Activity within the Tissue Industry

Seth Cureington¹ and Sun Joseph Chang¹

Abstract: Merger and acquisition activity among tissue producers has significantly altered market concentration. This paper tracks those changes and discusses the potential implications for future antitrust enforcement.

Key Words: antitrust, market efficiency, oligopoly, Herfindahl-Hirschman Index (HHI), elasticity

INTRODUCTION

The core of horizontal merger evaluation is market efficiency. The standard oligopoly theory as advanced by Chamberlain (1933), Fellner (1949), and Stigler (1964) has traditionally been the basis by which federal agencies responsible for regulating competition within the marketplace assess the impacts of increased concentration or decreased competition (White 1987). The Federal Trade Commission and Department of Justice, who are responsible for regulating competition within the United States marketplace, are concerned with efficiency and therefore must show that one of the following two outcomes is possible. The first question concerns concentration and its effects on industry profitability. If these agencies believe market efficiency is suffering because of increased concentration, they must provide proof that further concentrating the industry will have adverse effects such as allowing producers to reap excess economic profits. In the past researchers aggregated firms within an industry by net worth and studied how profitability changed with concentration. Some of these earlier empirical studies of the relationship between firm profitability and industry concentration include Bain (1951), Demsetz (1973), and Kwoka (1979). These papers weakly describe a relationship but call for more detailed research of those conditions that affect the profitability-concentration condition of an industry. Approaches such as these are based on the assumption that meaningful inference can be made from aggregate studies. A more direct approach, and one that is consistent with the empirical renaissance in industrial economics, is to study the individual firm. If the amount of excess economic profits extracted by the individual firm can be obtained from the data, dead weight loss needs to be calculated and compared to the gain seen by stockholders of the firm.

The second question concerns substitutability among firms' products. Some larger firms spend great sums of money in an effort to differentiate their products in the retail market. If the attempts at differentiation are successful consumers will likely resist changing their product choice when faced with small but significant changes in price. On the other hand, if consumers readily substitute among brands a competitive market is created. This is most relevant in the retail markets since the commercial products are much more homogeneous. Generally speaking though goods in both markets, outside of a few minor differences from product to product, are relatively homogeneous. There are also substantial barriers to entry so that increased concentration could theoretically reduce competition. Despite efforts by tissue producers to differentiate their products at the retail level, it seems logical that consumers will have some

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Approved for publication by the Director of Louisiana Agricultural Experiment Station as manuscript 03-40-1285.

degree of price sensitivity and therefore substitutes among brands. It is important that this degree of sensitivity be empirically tested.

This paper will highlight changes in market structure within the tissue sector of the pulp and paper industry. Characteristics of the pulp and paper industry that contributed to past merger and acquisition (M&A) activity include historically cyclical financial performance, highly volatile business conditions, and increasing cost of pollution abatement. Producers remaining throughout the late 20th century battled rising energy and raw materials costs, ever-changing supply and demand conditions, as well as obsolete machinery that needed to be replaced. These conditions required increases in capital expansion projects, which for many firms resulted in increased debt load.

Mergers & Acquisitions

The figure below tracks merger and acquisition activity over a 23-year period.

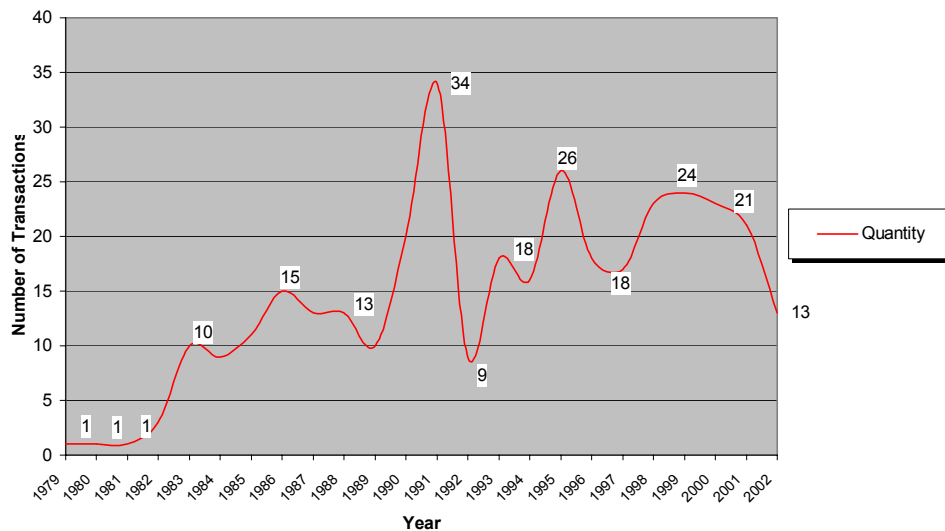


Figure 1. Mergers and Acquisitions of U.S. Pulp and Paper Mill Assets, 1979-2002

Merger and acquisition activity has been highly variable over this 23-year period but increasing nonetheless. An interesting aspect of the above trend is that most of the peaks occurred around periods of very low profitability. For example, during 1982-86, profits were under pressure and the number of mergers and acquisitions reached 15. As the decade continued profitability began to turn around and surged to record levels between the period 1987-89 where we see the activity decrease to somewhere around 10. As the pulp and paper industry entered 1990, the surge in profitability rapidly declined and fell to new lows because of a North American recession. Again, we observe a peak in M&A activity at 34 transactions. Given that peaks in horizontal activity appear to revolve around periods of poor aggregate financial performance, it might suggest that larger incumbent firms are responding to these market “signals” by submitting offers for smaller incumbent or newly entered firms when they are at their weakest financially.

Although financial performance would seem to be the dominant factor influencing past trends in M&A activity, changes in spending for environmental compliance also appear to have had an effect. Beginning in the 1970s, Congress passed an unprecedented amount of environmental legislation that drastically changed the way the paper industry was to treat air and water discharge. Some of the more stringent acts included the passing of and amendments to the Clean Air and Water Acts (1970-1990). Deadlines for compliance by firms came to a head in the late 1980s and early 1990s. The increase in offers made by larger incumbent firms for competitors might have been exacerbated by the costs associated with building facilities to comply with these acts. Increased costs associated with compliance could have been a factor in further weakening already struggling firms, which further explains the peak in M&A activity of the early 1990s.

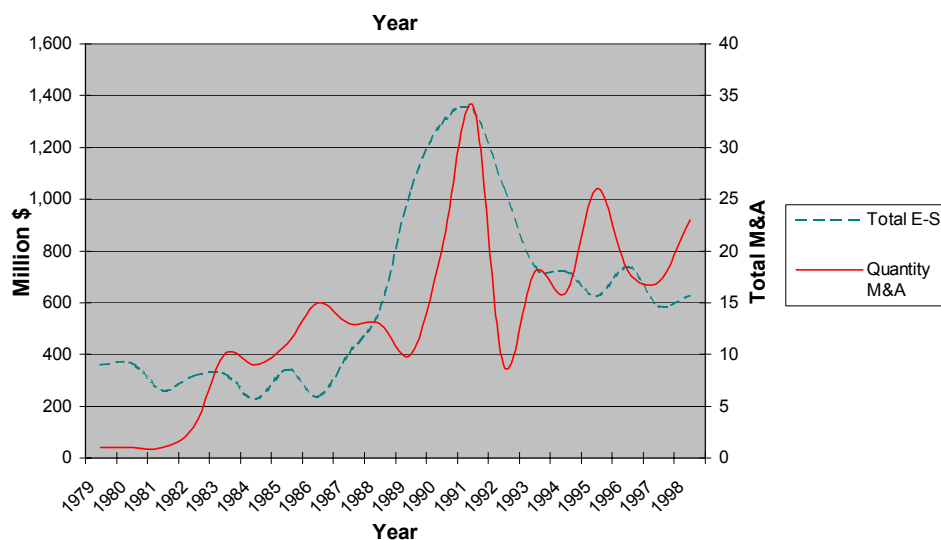


Figure 2. Total Environmental Spending v. Quantity of M&A, 1979-1998

All of this M&A activity begs the question: What are the implications for competition within the marketplace. If perfect competition is the metric for economic efficiency, then the tissue industry needs empirical assessment. Potential competition is important as a mechanism to control market power, as was observed by Clark, Bain, Sylos-Labini and others (Gilbert 1989). This aspect is particularly important in the tissue sector where short-run entry is for all relevant purposes impossible and long-run entry is characterized by substantial barriers in the form of high fixed investment required for plant and equipment. Obviously, a result of the wave of mergers and acquisitions is a reduction in the number of competitors. This suggests that there is less “potential” competition in the tissue industry.

The remaining sections of this paper will provide a description of the guidelines that the Federal Trade Commission (FTC) and Department of Justice (DOJ) use to assess proposed horizontal

ventures, and track changes in tissue-industry concentration levels as measured by the Herfindahl-Hirschman Index (HHI).

REGULATION

The 1992 Horizontal Merger Guidelines, jointly ratified by the FTC and DOJ, outline the criterion used to assess a potential merger between two companies. These two governmental agencies, as in the 1995 case against Kimberly-Clark and the 2000 case against Georgia-Pacific, continue to challenge horizontal mergers within the tissue industry. As Long, Schramm, and Tollison (1973) show, these agencies have sued in the past for various reasons, the most important of which seems to be industry size as measured by sales. The guidelines provide the private sector with the means to understand the agencies' goal in regulating anticompetitive mergers and the conditions under which enforcement will occur. The document unambiguously provides three significance levels for market concentration and the position taken on each. The agencies divide the spectrum of market concentration as measured by the HHI into three regions that can be broadly characterized as unconcentrated (HHI below 1000), moderately concentrated (HHI between 1000 and 1800), and highly concentrated (HHI above 1800) (1992 Horizontal Merger Guidelines). Each agency considers pre, as well as post merger HHI and provides for the allowable level of increase in concentration for each significance level. For example, if a particular firm proposes a horizontal merger within a moderately concentrated sector, the agencies will consider the merger anticompetitive if it produces a post merger increase in HHI of more than 100 points. This merger would be equivalent to two firms with approximately 8 percent market share each. Within highly concentrated industries, post merger concentration should not increase by more than 50 points for the agency to accept the venture.

The guidelines also provide for those circumstances that either weaken or aggravate the effects from increased market concentration. They include factors affecting the significance of market shares and concentration, potential for adverse competitive effects from mergers, entry analysis, as well as a failure and exiting assets provision.² The tissue industry satisfies the condition, as outlined by the FTC and DOJ, such that any horizontal merger could potentially degrade competition. Those factors most responsible include the limited entry hypothesis and the production inputs and product homogeneity hypothesis, which aggravate a situation where many firms are competing and or distinguished by their relevant capacities.

IV. Sector Analysis

Tissue

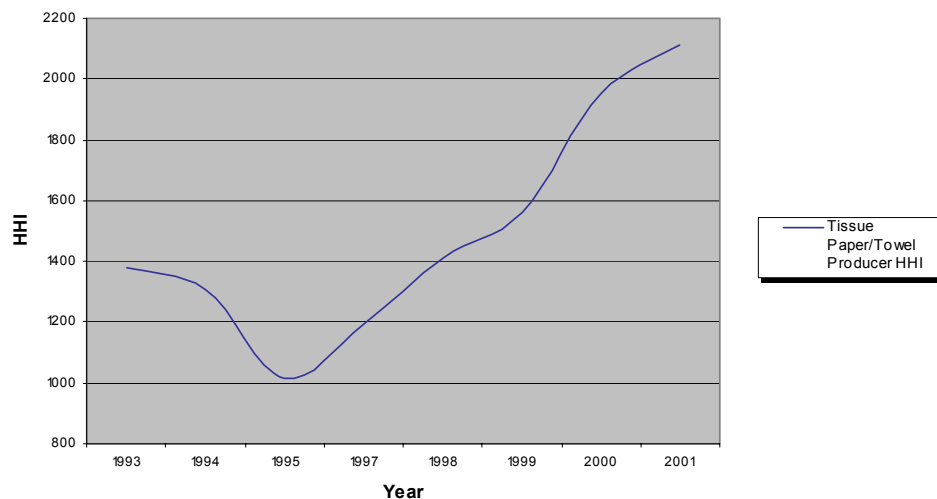
An excerpt from the 2002 North American Pulp & Paper Fact-book summarizes the relevant markets of the tissue industry:

Tissue paper is used in sanitary products such as bath tissue, paper towels, facial tissue, and napkins, and is sold in both the consumer and commercial/industrial (C&I) markets. Also called the "at home" market, consumer tissue accounts for about two-thirds of the U.S. tissue trade and is purchased at retail outlets such as super markets and drug stores. C&I tissue, also called the "away from home" market, represents most of the remaining shipments and is sold at wholesale to janitorial supply companies, hotels, offices, restaurants, factories, airports, schools, and

² For a detailed list, see the "1992 Horizontal Merger Guidelines" published and jointly accepted by the FTC and DOJ.

government offices. A small quantity of tissue is used in absorbent products such as diapers, wipes, and feminine hygiene. Tissue paper is also used for wadding and as base-stock for waxing, wrapping, and miscellaneous uses.

Market concentration is simply the sum of individual firm's respective market shares squared. This measure is most relevant when the percentage dollar-market-share that a particular firm's product claims is used in the calculation. This paper reports both the aggregate HHI and individual product class HHI for the tissue industry, the former of which is based on capacity shares and the latter on dollar-market-shares to convey the idea that measures based on the former can understate the degree of concentration within a market. The retail market for tissue is important to study because of the ability of "at home" tissue producer's output decisions to have a direct impact on shelf prices and consequently consumer welfare. At first glance it would seem that the degree of concentration would allow producers to have substantial pricing power; however, that may not be the case. The accurate estimation of own and cross-price elasticities of demand would prove invaluable in determining producer pricing power. On the other hand, manufacturers of C&I tissue products sell at the wholesale level and in large quantity to individual customers. This allows those producers to pass price increases along because of the inability or costs to the institutional customer of switching their account to another supplier. This suggests that the price elasticities of demand for institutional customers are somewhat lower than those associated with the retail market. More cases have been brought against the C&I, or "away from home" market than the "at home" market in the past, which, at least superficially, suggests



that the pricing power of firms is more apparent in the C&I market.

Figure 3. Trends in North American Tissue Industry Concentration

Starting in the early 1990s, branded producers faced increasing competition from Kimberly-Clark's entry into the bath tissue segment and from the increase in private label producers' market shares. This caused a temporary decrease in concentration (potential increase

in competition) where we observe HHI in figure 3 bottoming out at around 1000 points. Kimberly-Clark's acquisition of Scott Paper in 1995 marked the beginning of a wave of mergers that would continue to increase market shares of the top firms. Mergers contributing to this consolidation include the 1997 purchase of James River Corp. by Fort Howard Corp., a merger between Wausau Paper Mills Co. and Mosinee Paper Corp., purchase of Fort James Corp. by Georgia-Pacific in 2000, and finally Canadian company Cascade's purchase of bankrupt American Tissue Inc. in 2002. Whatever the reason, the impacts on concentration levels have been enormous and deserve further analysis.

As exhibited in figure 3, all of this consolidation has doubled the concentration level since 1995 and placed the industry in the highly concentrated range as measured by the HHI. This has very strong implications for future horizontal M&A within the tissue industry, because the regulatory agencies will likely prevent any future proposals that result in a post-merger increase in HHI by more than 50 points unless sufficient assets are divested. Figure 3 is based on capacity share data for the aggregate tissue industry and does not discriminate between product classes. Discriminating between individual product classes *and* each producer's respective dollar-market-share of the "at home" market draws a much different picture.

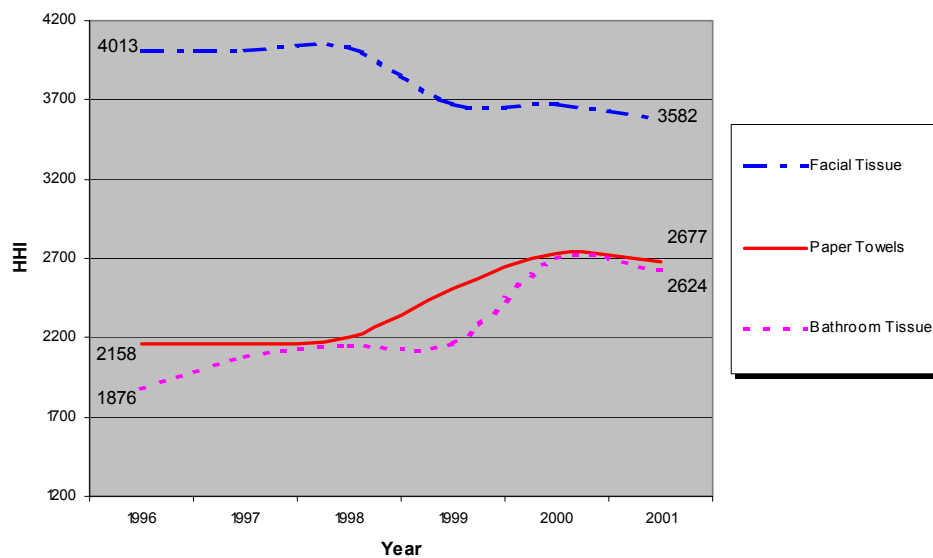


Figure 4. Industry Trends in AH Tissue Industry Concentration

Figure 4 exhibits the recent trends in three retail tissue markets. An important change that occurred during this period was the claim of market share by firms with branded products either by acquiring other firm's assets and product brands or developing superior branded products early on. This at least seems to be consistent with the logic behind a product's life cycle.³ Market concentrations have only recently succumbed to the increase in private label producer's dollar-market-share. This share is treated as one producer in the above graph, which can overstate HHI

³ For a discussion of product life cycle and the logic of a model that describes this cycle, see Klepper (1996).

by a maximum of 300 points. If the dollar-market-shares of the private label producers were removed, the sectors would all remain highly concentrated.

An important question that has not been answered is what level of profitability the firms in this market have been able to secure because of the substantial barriers to entry, and further what impact this has had on efficiency and or consumer welfare. The idea of excess economic profits is feasible if, for no other reason, than the very substantial barriers to entry within the tissue industry. Producers must purchase and build tissue machines that produce parent rolls, which are bulky and consequently costly to transport. (This is the only comment I have on geographic market definition of the tissue industry. It is implied here that the market is regional with respect to the plant and consequently products are rarely shipped long distances.) Many integrated producers have converting facilities so that large markets can be secured. This strengthens the incumbent firm's position, allowing for some degree of price flexibility. Rivals are limited in their ability to respond to decreased output decisions of their competitors since most produce at or near full capacity. Again, when figure 3 is compared to 4, we see that actual concentration can be understated.

Although it is important to aggregate each firm's dollar-market-share, it is equally important to assess individual product characteristics. Quantifying elasticity of demand for a product allows the dollar-market-share to be put in perspective. For instance, many firms are characterized by owning branded products that can range in quality and value depending on price. This product differentiation increases total sales and consequently market share. The elasticity of demand for each product eludes to the degree of flexibility firms have in terms of taking advantage of products with relatively low elasticity of demand (less resistant to price change) with the understanding that the lost sales could be picked up through the higher elasticity (more resistant to price change) brand. Inferring the degree to which this can occur is at best speculative when looking only at a firm's aggregate dollar-market-share.

CONCLUDING REMARKS

A myriad of factors contribute to an analysis of a proposed merger, the most important of which are a set of own and cross-price elasticities (Wu 2003).⁴ The concentration-profitability hypothesis is important, but does not allow one to look at the merged firm's impact on prices. Elasticity, if indeed accurate, supersedes all other measures because it unveils the true degree of pricing power that individual firms have. This implies that future research should be directed toward developing econometric models that accurately estimate elasticities as mentioned above. Elasticity allows the effects of barriers to entry, market structure, firm behavior, and other similar questions pertaining to the tissue industry to be placed in perspective.

Although future research is needed in all relevant areas, it does not alter the fact that the regulatory authorities rely heavily on the Herfindahl-Hirschman Index as a signal of the potential for degradation of competition. It is for this reason that party's interested in future horizontal mergers in the tissue industry should pay close attention to the impact that the proposed venture would have on this measure of market concentration.

⁴ For an alternative to the complex econometric approach, see Epstein and Rubinfeld (2002).

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An Economic Feasibility Study for Recreational Development on the Bienville National Forest in Mississippi

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Abstract: An economic impact analysis for recreational development on the USDA Forest Service's Bienville Ranger District indicated the potential for a new, long-term revenue stream to the four counties encompassing Bienville National Forest (BNF). Economic impacts were based on annual net returns for proposed and enhanced recreational activities, associated with a 1,000-acre lake, derived from new non-resident dollars. Estimates for total visitation in activity days ranged from 543,500 to 1.46 million. Economic impacts were based on minimum and maximum non-resident visitation at 40% (current BNF estimate) and 70% of total visitation. At 40% and 70%, net total sales impacts for non-resident visitation ranged from \$10.43 to \$28.60 million and \$18.52 to \$49.16 million, respectively. Net annual, indirect business taxes were used as a funding benchmark for the long-term sustainability of proposed or enhanced recreational activities. This benchmark was \$1.31 million, which equals the current U.S. government, short-term funding provided to the four counties. Net indirect business taxes, based on minimum and maximum projections for non-resident visitation at 40% and 70%, totaled \$765,656 to \$2.05 million and \$1.47 to \$3.73 million, respectively. Overall, results were favorable for initiating proposed and enhanced recreational activities. The break-even point was a non-resident visitation of 356,751.

Key Words: economic impact analysis, indirect business taxes, National Forests, recreation, rural development

INTRODUCTION

In 1999, representing Smith County, Mississippi community leaders met with personnel from the National Forests in Mississippi to request agency support of their proposal to develop a large recreational lake on the Bienville National Forest (BNF) in Smith County, Mississippi. The objective of constructing the lake was to create a setting that will be conducive to investment in large-scale recreation development. It was believed that once the lake was developed tourism and tourism-related services would increase, thereby providing an additional source of revenue for Smith County and the surrounding area. The increase in economic development was expected to help offset declining federal payments to the county (Twenty-five Percent Fund), attributed to the reduction of National Forest timber sales.

In 2000, the 106th Congress (H.R. 4578) directed the U.S. Forest Service (USFS) to conduct an economic feasibility study of the impacts of constructing a recreational lake on the BNF in Jasper, Newton, Scott, and Smith Counties in Mississippi. To facilitate completion of the study, the National Forests in Mississippi formally entered into an agreement with the

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Mississippi Water Resources Institute and the Department of Forestry at Mississippi State University to conduct the study prior to further planning and development.

The overall project objective was to determine economic feasibility for long-term recreational development, particularly for a large recreational lake in BNF in Mississippi. The study examined long-term economic feasibility based on the increase in economic impacts and taxes generated from proposed recreational activities and visitor participation rates versus economic impacts and taxes generated from the current mix of recreational activities and participation rates and federal payments from national forest management activities. The current mix of activities that would be affected by the BNF developments included ATV use, biking, boating, camping, fishing, hiking, horseback riding, picnicking, and swimming. The proposed activities included newly introduced or enhanced ATV designated trails, biking, boating (non-anglers), conference center activity, fishing, fishing tournaments, hiking, horseback riding, jet skiing, outdoor education, picnicking, playground activity, shooting range activity, sightseeing, swimming, water skiing, and wildlife-watching.

METHODS

Initially, an assessment was made of existing recreational activities and facilities in BNF, which lies within Jasper, Newton, Scott, and Smith Counties. Consideration was given to additional or enhanced recreational activities and facilities, particularly a large recreational lake that could be incorporated into the forest setting. These proposed or enhanced activities and facilities were incorporated into the study based on discussions with the U. S. Forest Service and the Smith County Board of Supervisors, and through the use of a pilot survey. Varying investment levels needed to provide new activities and facilities, and the monetary benefits derived from these investments, were evaluated for their long-term feasibility. In addition, investigations uncovered the socio-demographics within a 150 and 300-mile radius around Bienville National Forest. Other recreational sites also were catalogued within the 150-mile radius to assess potential markets for planned activities.

Feasibility, from the standpoint of tax generation, would be determined through the use of Economic Impact Analysis (EIA). Economic impacts, founded upon the fundamentals of input-output analysis, are especially useful in describing current and potential economic roles of travel and tourism activities and facilities (e.g., water skiing, fishing) in an overall economy (USDI 1992, Johnson and Moore 1993, Strauss et al. 1995, Grado et al. 1997). Economic impacts are generated from models developed by using the Impact Analysis for Planning (IMPLAN) System (Alward et al. 1985). This software was originally developed by the USFS to estimate regional economic impacts of management plans for National Forests (Olson and Lindall 1999). These studies provide regions or states with useful information about social and economic effects of proposed projects (Loomis and Walsh 1997). Economic impacts of potential investments providing new or enhanced recreational activities at BNF would be modeled using IMPLAN to determine the monetary value to the 4-county economy from these new activities.

One issue of concern for any economy is leakage that occurs when dollars are spent. Leakage is defined as those dollars attributed to foreign or domestic imports, purchases of commodities produced by government and other institutions, and those portions of value-added which are not respent in the region (Olson and Lindall 1999). For each activity, a leakage value was produced and served as a measure of the potential for future economic impact. These impacts would result from the creation of businesses both directly and indirectly associated with BNF and its activities. In addition, multipliers derived from economic impact analysis can be

used to assess relationships in a local or regional economy (Loomis and Walsh 1997). Multipliers show how direct sales promote other effects on total economic output. We examined Type II multipliers, which are total sales output for the region divided by the direct sales.

Preferably, expenditure data should be collected on recreation-related activities directly from visitors participating in a specific region. However, due to time constraints and the unavailability of data, information was collected from a variety of sources. In some cases, this data was previously collected in Mississippi, although not for BNF. In other cases (e.g., ATV use), secondary data sources were relied on to develop expenditure profiles. In both cases, this included daily expenses (both on-site and off-site) and expenses for durable items like ATVs or other vehicles. For EIA purposes, all expenses have been converted into a per day basis. To truly assess the economic impacts to the four county region, we also needed to know what was spent in this region versus purchases spent outside this area. In cases where purchase location was unknown, IMPLAN's Regional Purchase Coefficients for the four counties served as a proxy for the upper limit on expenditures for specific items purchased in those four counties.

Another issue addressed when estimating economic impacts is residency of recreationalists. Typically, non-residents have more impact on economies than residents because their expenditures represent an influx of new money. Resident expenditures are commonly excluded when determining impacts because it is theorized that, in lieu of the activity of concern, they would spend that money in another way. Residents also may go to other areas to recreate, leading to decreased local expenditures. In this study, resident expenditures were excluded from the EIA. In addition, separate economic impacts were not performed for lodging facilities such as the conference center, cabins, RV stations, and camping sites because expenditures associated with these sites were built into the expenditure profiles for activities under analysis. Care was also taken to estimate attendance for each activity without duplicating recreational participants under multiple activities. This avoided, to the extent possible, the double counting of participants and their expenditures on a given day for multiple activities.

RESULTS

The estimated economic impacts were summarized from proposed or enhanced recreational activities on BNF based on minimum and maximum activity days used for each activity at a 40% and 70% non-residency visitation rate, respectively (Tables 1-4).

Table 1. Total estimated economic impacts from proposed or enhanced recreational activities on Bienville National Forest based on minimum activity days used for each activity and a 40% non-residency visitation rate.

Proposed Activity	Total Sales Impact \$	Percent %	Indirect Business Taxes \$	Percent %	Employment #	Percent %
ATV Designated Trails	400,319	3.64	25,533	3.18	11	3.92
Biking	13,293	0.12	859	0.11	0	0.11
Boating (non-anglers)	1,387,410	12.62	103,853	12.91	33	12.27
Conference Center	121,541	1.11	7,308	0.91	3	1.15
Fishing	1,235,343	11.24	117,577	14.62	33	12.20
Fishing Tournaments	97,191	0.88	3,915	0.49	2	0.67
Hiking	570,532	5.19	54,878	6.82	15	5.66
Horseback Riding	620,773	5.65	30,748	3.82	12	4.55
Jet Skiing	181,214	1.65	9,271	1.15	3	1.18
Outdoor Education	11,821	0.11	969	0.12	0	0.11
Picnicking	786,960	7.16	54,186	6.74	20	7.21
Playground Activity	78,696	0.72	5,419	0.67	2	0.70
Shooting Range	34,233	0.31	3,574	0.44	1	0.33
Sightseeing	1,573,918	14.32	108,372	13.48	39	14.42
Swimming	3,147,838	28.64	216,744	26.95	78	28.84
Water Skiing	473,597	4.31	36,609	4.55	11	4.14
Wildlife-Watching	254,980	2.32	24,324	3.02	7	2.55
Totals	10,989,659	100.00	804,139	100.00	270.5	100.00

Table 2. Total estimated economic impacts from proposed or enhanced recreational activities on Bienville National Forest based on maximum activity days used for each activity and a 40% non-residency visitation rate.

Proposed Activity	Total Sales Impact \$	Percent %	Indirect Business Taxes \$	Percent %	Employment #	Percent %
ATV Designated Trails	1,200,955	4.12	43,849	2.10	12	1.69
Biking	19,939	0.07	1,289	0.06	1	0.07
Boating (non-anglers)	2,081,115	7.14	155,780	7.46	50	7.31
Conference Center	729,245	2.50	43,849	2.10	19	2.77
Fishing	3,706,028	12.71	352,731	16.89	99	14.55
Fishing Tournaments	242,978	0.83	9,787	0.47	5	0.76
Hiking	1,597,491	5.48	153,659	7.36	43	6.28
Horseback Riding	1,862,321	6.39	92,243	4.42	37	5.40
Jet Skiing	497,648	1.71	50,036	2.40	13	1.85
Outdoor Education	35,464	0.12	2,907	0.14	1	0.13
Picnicking	3,147,838	10.79	216,744	10.38	78	11.45
Playground Activity	204,609	0.70	14,088	0.67	5	0.75
Shooting Range	410,790	1.41	42,892	2.05	11	1.59
Sightseeing	5,508,716	18.89	379,302	18.16	137	20.04
Swimming	6,295,676	21.59	433,488	20.76	156	22.89
Water Skiing	1,200,955	4.12	54,913	2.63	17	2.47
Wildlife-Watching	424,967	1.46	40,540	1.94	0	0.00
Totals	29,166,735	100.00	2,088,097	100.00	681.2	100.00

Table 3. Total estimated economic impacts from proposed or enhanced recreational activities on Bienville National Forest based on minimum activity days used for each activity and a 70% non-residency visitation rate.

Proposed Activity	Total Sales Impact \$	Percent %	Indirect Business Taxes \$	Percent %	Employment #	Percent %
ATV Designated Trails	700,557	3.67	44,683	3.17	19	3.69
Biking	23,262	0.12	1,503	0.11	1	0.12
Boating (non-anglers)	2,427,967	12.72	181,744	12.91	58	11.52
Conference Center	212,697	1.11	12,789	0.91	6	1.09
Fishing	2,161,849	11.33	205,759	14.62	58	11.46
Fishing Tournaments	170,084	0.89	6,851	0.49	4	0.71
Hiking	998,432	5.23	96,037	6.82	27	5.29
Horseback Riding	1,086,354	5.69	53,809	3.82	22	4.26
Jet Skiing	116,118	0.61	11,675	0.83	3	0.57
Outdoor Education	20,687	0.11	1,696	0.12	1	0.10
Picnicking	1,377,179	7.22	94,826	6.74	34	6.76
Playground Activity	137,718	0.72	9,483	0.67	3	0.67
Shooting Range	109,602	0.57	11,305	0.80	3	0.63
Sightseeing	2,754,358	14.44	189,651	13.47	68	13.52
Swimming	5,508,716	28.87	379,302	26.94	137	27.06
Water Skiing	828,796	4.34	64,065	4.55	20	3.89
Wildlife-Watching	446,216	2.34	42,567	3.02	44	8.66
Totals	19,080,592	100.00	1,407,745	100.00	504.5	100.00

Table 4. Total estimated economic impacts from proposed or enhanced recreational activities on Bienville National Forest based on maximum activity days used for each activity and a 70% non-residency visitation rate.

Proposed Activity	Total Sales Impact \$	Percent %	Indirect Business Taxes \$	Percent %	Employment #	Percent %
ATV Designated Trails	2,101,672	4.23	134,048	3.55	56	4.40
Biking	34,892	0.07	2,255	0.06	1	0.07
Boating (non-anglers)	3,641,950	7.32	272,615	7.23	87	6.87
Conference Center	1,276,179	2.57	76,735	2.03	33	2.60
Fishing	6,485,548	13.04	617,278	16.36	174	13.69
Fishing Tournaments	425,210	0.86	17,127	0.45	9	0.70
Hiking	1,741,594	3.50	268,903	7.13	75	5.91
Horseback Riding	3,259,062	6.55	161,426	4.28	64	5.08
Jet Skiing	870,883	1.75	87,562	2.32	22	1.74
Outdoor Education	62,063	0.12	5,088	0.13	2	0.13
Picnicking	5,508,716	11.08	379,302	10.06	137	10.77
Playground Activity	358,066	0.72	24,655	0.65	9	0.70
Shooting Range	1,315,219	2.64	135,660	3.60	39	3.04
Sightseeing	9,640,253	19.39	663,779	17.60	239	18.84
Swimming	11,017,433	22.16	758,604	20.11	273	21.53
Water Skiing	1,243,194	2.50	96,098	2.55	29	2.32
Wildlife-Watching	743,692	1.50	70,945	1.88	20	1.59
Totals	49,725,626	100.00	3,772,080	100.00	1267.4	100.00

Total economic impacts from current activities were \$563,395, with indirect taxes of \$38,483 and 15 jobs supported. As previously stated, economic impacts from current activities in the forest were subtracted from proposed and enhanced activities associated with a 1,000-acre lake. This was done for a minimum and maximum projection for non-resident visitation at both the 40% and 70% levels. This resulted in a minimum and maximum range for net total sales impacts of \$10.43 to \$28.60 million at 40% non-residency. For 70% non-residency, net total sales impact minimum and maximum range was \$18.52 to \$49.16 million. This also resulted in a minimum and maximum range of an annual net employment impact of 256 to 505 jobs at 40% non-residency. For 70% non-residency, annual net employment impact minimum and maximum range was 490 to 1,253 jobs. In general, the largest impacts for sales, taxes, and employment were derived from swimming, sightseeing, boating (non-anglers), and fishing.

Tax contributions of current and proposed or enhanced recreational activities fall into two broad categories; those that are collected and stay in the local four county region and those that are collected and do not. For the most part, the majority of the indirect business taxes stay in the local area and are respent. The "other" tax category primarily includes federally related taxes, most of which leave the local area. For the purposes of this study, it was assumed that net annual, indirect business taxes could be used as a benchmark for long-term sustainability of proposed or enhanced recreational activities in BNF. When non-resident visitorship stayed at 40%, net indirect business taxes, based on minimum and maximum projections for non-resident visitation, totaled \$765,656 and \$2.05 million, respectively. When the non-resident visitorship was projected to 70%, net indirect business taxes, based on minimum and maximum projections for non-resident visitation, totaled \$1.37 and \$3.73 million, respectively. The overall annual net tax gain, with non-resident visitorship at 40%, totaled \$1.92 and \$5.14 million, respectively. The overall annual net tax gain, with non-resident visitorship projected to 70%, totaled \$3.42 and \$9.27 million, respectively.

DISCUSSION

Economic Impact Analysis

Economic impacts in this study represent a new, long-term revenue stream to the four counties encompassing BNF. The economic impacts are an annual net return (proposed or enhanced activities minus current activities) based on the proposed and enhanced activities associated with a 1,000-acre lake derived from non-resident dollars that exclude the economic impacts from current, non-resident activities in the forest.

There were a number of variables in this study that had an influence on its outcome. The key variables included potential participation rates by visitors for new or enhanced activities, treatment of residency status of recreationists used in the EIA, estimates for non-resident visitation, and expenditure profiles, all of which were acquired from secondary data sources. In some cases current data were acquired in Mississippi, although not at BNF.

There were a number of activities proposed for BNF for which there were no recreation or tourism-related expenditure studies to acquire the necessary expenditure profiles and attendance data. The same was true of these activities for the state of Mississippi. As a result, making conjectures based on limited, localized data was difficult, particularly if these data were to be used for economic impact analysis. However, available data and the implementation of an economic impact analysis over a range of values revealed the possibilities for determining economic feasibility of proposed and enhanced recreational opportunities at BNF.

Overall study results indicated the proposed project is, for the most part, economically favorable from a tax generation standpoint. The project was not feasible from the standpoint of indirect business taxes when non-resident visitation remained at 40% or when projections approached the minimum visitation for all activities involved. However, as visitation projection approached the maximum, the project became feasible. If all activities remained at 40% non-resident visitation, there was an annual shortfall of \$543,864 in indirect business taxes from the \$1.31 million the government now provides. However, when non-resident visitation reached the maximum projection there was a positive annual gain of \$740,094. If non-resident visitation is 70%, both minimum and maximum visitation projections show positive annual gains of \$59,742 and \$2.42 million, respectively. The break-even point was a non-resident visitation of 356,751.

The range of values for indirect business tax generation will likely be higher if the BNF 1,000-acre lake is built and accompanying activities are incorporated. There are several reasons for this optimism. One, the use of 40% for non-residents was an estimate given by BNF and verified by the pilot survey. However, this does not consider any marketing activities that would take place to promote the new BNF lake and associated recreational activities. Also, if proposed or enhanced changes in BNF become a reality, coupled with new highway projects due to take place in the near future, visitation will most certainly rise. Thus, the non-resident portion of visitation will likely increase to at least 50% and perhaps as high as 70% and, along with it, so will the economic impacts and accompanying tax generation. For this reason, a range of 70% was incorporated into this analysis to project high end economic impacts and tax benefits from increases in non-resident visitation. However, while these non-residency estimates are average projections, each recreational opportunity will vary in its resident/nonresident distribution. Second, the new BNF 1,000-acre lake will inevitably lead to an expansion of existing businesses and the creation of new firms. This will result in increased economic impacts and tax generation both directly from these enterprises and indirectly from the surrounding businesses in the four counties. It should be noted that this study was accomplished with a 1998 version of the four county economy. Once proposed and enhanced activities become reality, a new economy in the area will develop which will capture more dollars on the local level. These new enterprises (i.e., retail, wholesale, and manufacturing) will help stem the leakage from the four counties which was estimated to range, at 40% non-residency, from \$10.89 to \$28.84 million. For 70% non-residency, leakage was \$19.01 to \$51.33 million. Third, the \$1.31 million that the U.S. government will provide annually to the four counties is only guaranteed until 2007. There is no guarantee that these funds will continue. Improvements made to BNF for recreation will, despite variations in the economy, still provide a more stable income and tax base for the four counties. Fourth, funds coming from the government will not be indexed to the inflation rate. In contrast, total sales impacts and resulting taxes will keep pace with inflation. For example, purchasing power of the \$1.31 million provided by the U.S. government will continually erode whereas tax dollars will continue to increase because they are based on sales of products that will inflate annually at a rate of at least 2-3%. Last, resident expenditures have been ignored in this project as contributors to economic impacts and the resulting tax base increase. Studies have been done to determine the contribution resident expenditures make to economic impacts (Grado et al. 2001). In a waterfowl hunting study in the Mississippi Delta, it was determined that 70% of resident expenditures would leave the area to pursue duck hunting elsewhere and could be considered legitimate impacts. Therefore, a portion of resident expenditures could be added to the non-resident totals for total sales impacts and indirect taxes, thus increasing these numbers even further.

It should be noted that this project, while generating new revenue, will also lead to additional costs. These may range from new law enforcement costs (e.g., problems with unauthorized ATV use on private lands if ATV use was emphasized on BNF) and costs associated with increased traffic, or sewage treatment operations. However, most of these expenses related to infrastructure can be built with state and federal assistance. Counties also have dollars in their budgets for some of this expansion. Also, as the economy in the four counties changes with developments not directly related to activities in the forest, their tax bases will also increase.

Rural development initiatives, assisted by state and federal agencies and private businesses, can improve local economies by marketing and planning developments that accommodate the resource's of BNF and its users based on economic impact analysis. We used economic multipliers, derived from our study results, to illustrate the region's ability to incorporate and use in-region recreational expenditures. The Type II multiplier for our study region was 1.46 indicating that for each dollar spent in the region there is an additional \$0.46 of economic impact. In general, a multiplier of 1.46 for these types of activities is somewhat low and indicates that the study region is failing to capture recreational expenses, and that many supporting businesses are located out of four county study region. Regional and state level output multipliers for recreation expenditures usually range from 1.5 to 2.7 in the United States (Loomis and Walsh 1997). Grado et al. (1997) determined that turkey hunting in Mississippi produced a multiplier of 2.3. However, multiplier size may be related to the size of region because value added within a region increases as its geographic area is increased and a smaller proportion of expenditures are purchased outside the region (Loomis and Walsh 1997). This state multiplier is greater than our study multiplier, in part, because the industrial capacity of the state surpasses that of the four county area of BNF and more expenditures are captured within the state economy. The industrial or commercial make-up of an area influences the size of the multiplier. A study of anglers in Maine produced a multiplier for non-resident expenditures of 1.60 (Steinback 1999). In a study of nine rural counties in Pennsylvania, Strauss et al. (1995) produced a multiplier of 2.96 for all recreational activities by non-residents, with the range extending from 2.29 to 3.42. By comparison, the range for our study was 1.40 to 1.49.

Marketing Analysis

The creation of a 1,000-acre recreational lake within BNF would be convenient for single-day and multiple-day travelers. The National Forest is conveniently located between Jackson and Meridian, Mississippi and is easily reached by interstate from Memphis, Tennessee, New Orleans, Louisiana, and Atlanta, Georgia. In addition, the National Forest is only 30 miles from the Silver Star and Golden Moon Casinos in the Choctaw Reservation near Philadelphia, Mississippi.

Funds to promote marketing of BNF and surrounding recreational sites would be provided primarily by private enterprise, since it is envisioned that they would have a key role in recreational activity development. A review of competing sites and activities, from a geographical standpoint, shows that there are many recreational opportunities that could be developed in coordination with a 1000-acre lake at BNF (Grado et al. 2002). For example, an important activity would be the development of an 18-hole golf course in the vicinity of BNF. Only 5 of 80 state and federal recreational areas offer this activity in Mississippi. Another opportunity is the development of ATV trails. Currently, BNF offers limited ATV opportunities, but expanding existing trails would help develop an important niche for this outdoor recreational

market. Further support for developing enhanced ATV activities is that recreational sites in the surrounding states of Alabama, Arkansas, and Louisiana do not offer designated ATV trails. It should be noted that while the pilot survey in this study showed no large opposition to ATV use there is a good deal of pressure to eliminate or severely limit ATV use on federal lands. However, elimination of ATV use at BNF would not jeopardize the feasibility of the 1,000-acre lake. It is also important to note that the largest impacts for sales, taxes, and employment were derived from boating (non-anglers), fishing, sightseeing, and swimming. All of these activities are viewed as relatively benign from an environmental standpoint.

Some of the activities on the Lake Project may be mutually exclusive and/or may not be feasible to provide. For example, jet skiing and water skiing may conflict with fishing tournaments. However, the conservative use projections of this study will assist recreational planners in developing recreational opportunities that will not only be feasible but avoid user conflicts. The use projections for this project (activity days) are in-line with visitation on other National Forests (Zinser 1995). If certain activities meet with public resistance or are unable to be successfully incorporated into the Lake Project, they can be dropped from the data provided by this report to assess the monetary losses for the four counties.

Although, convention centers and cabins are found on other federal lands and state parks within Mississippi, an opportunity exists for developing a unique convention center not found elsewhere in the state. These facilities could be built in conjunction with visitor activity buildings stressing outdoor education, which are only found in State Parks within Mississippi. Other activities that are not common and could be developed include horseback riding trails, shooting ranges, group and RV camping facilities, and other educational programs. It is also possible to expand upon wildlife-watching activities on BNF. For example, endemic species along with other species attached to a large lake would make this a key visit along a proposed birding trail for the South.

CONCLUSIONS

The study conclusions are based on a conservative approach given the treatment of key variables in this study. Those variables included present and future attendance estimates provided by BNF and competing recreational sites, residency of participants, and their estimated expenditure profiles. A major change in any of these factors could influence the results. However, the range provided for long-term total sales impacts, employment, tax dollar generation provides a measure of assurance as work on the lake progresses.

The long-term positive results from this study necessitated that the project moves on to the next stage. It has been estimated that it will cost \$2.85 million and take three years to complete an Environmental Impact Statement (EIS). Once the EIS is complete and the feasibility of the project is determined, it will cost approximately \$25.00 million and take from five to eight years to accomplish: 1) land and mineral acquisitions; 2) design and construction of the dam; 3) wildlife and fisheries habitat enhancement projects; 4) vegetation management; 5) basic infrastructure development; and 6) preparation of a prospectus and design narrative for solicitation/award of a long-term special-use permit for private sector development/operation of the recreational facilities.

Successful implementation of a project of this magnitude will also require significant investment from the state and counties, in combination with the federal government, for required infrastructure development (i.e., road improvements, sewage treatment facilities). Mississippi has appropriated \$1.25 million for the construction of turn-out lanes from State Highway 98 into

the Okhissa Lake Project in Franklin County, Mississippi. Design and construction of required sewage treatment facilities is expected to cost Franklin County an estimated \$3.5 million.

FUTURE CONSIDERATIONS

The experience from this study highlights the need for a coordinated effort in Mississippi on the part of those members of the outdoor recreation community and their stakeholders to coordinate studies that look at visitor attendance, expenditures, values, attitudes, and perceptions relative to the natural resource base. This information is invaluable for economic feasibility studies, making decisions that affect the natural resource base, and promoting a natural resource-based tourism economy in the state.

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Modeling the Demand for and Value of OHV Recreation in Tennessee

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Abstract: This analysis is an extension of research undertaken for the Study Committee on Off-Highway Vehicles to assess the importance of off-highway vehicle recreation to the state of Tennessee. This research aims to address a need for economic modeling focused on off-highway vehicle (OHV) recreation. With the rise in popularity of this sport and the shortage of places to participate, advanced research techniques are needed to ensure the efficient and effective management of OHV recreation in Tennessee. Travel cost techniques are used to model the demand for and value of OHV recreation. A conventional welfare measure, maximum willingness to pay, is estimated from travel cost information.

Key Words: Consumer surplus, travel cost method, willingness to pay, Poisson

Funding for the project was provided by the Tennessee Agricultural Experiment Station and the Tennessee Department of Environment and Conservation

INTRODUCTION

Public and private lands alike offer a variety of trails coupled with beautiful surroundings that make Tennessee a popular area for off-highway vehicle (OHV) recreation.⁶ It is estimated that each year over 500,000 people visit national forests, state riding areas, or private lands to enjoy the natural surroundings and their vehicles (Fly et al. 2001). Along with the growing popularity of OHV recreation in Tennessee, demand for areas that provide for such recreation has increased substantially. Most riders seek vast areas with secluded trails and prefer these trails to consist of some type of mountainous terrain. Due to increasing amounts of land development and conversion, however, available areas of mountainous wooded terrain are becoming increasingly difficult to find. State and federal agencies are often forced to designate certain areas in state and national forests for OHV riding only to prevent user conflicts with other types of recreation. However, many states do not budget funds for OHV areas. This leaves many land management agencies struggling to allocate funding for supervision, safety, and the extensive trail maintenance needed in OHV areas; ultimately, leading to closure or additional

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⁶ Off-highway vehicles are considered to be any type of motorized vehicle that can be taken off of the road. Examples may include off-highway motorcycles, ATVs, four-wheel drive vehicles, or rail buggies.

restrictions imposed on the recreation site. Restrictions and closures in public riding areas often result in riders' venturing onto restricted public and private properties. Tennessee Code Annotated Section 70-7-101, et seq., (commonly called the "Recreational Use Statute") protects both private and governmental entities from injury lawsuits unless the landowner charges a fee or "consideration" to ride on his land. In most cases, landowners who do not charge a fee are protected from liability for simple negligence. However, landowners who allow riding on their property and charge a "consideration" or fee to offset the costs related to the OHV activity forfeit any protection offered under the Recreational Use Statute.

In November 1999, Tennessee Governor Don Sundquist appointed the Study Committee on Off-Highway Vehicles to evaluate the use, impact, and availability of OHV recreation in Tennessee and to address emerging economic, social and environmental issues related to this growing sport. The state extended invitations to relevant public agencies and to citizens' groups to participate in the committee. The Governor's Study Committee on Off-Highway Vehicles recommended that a formal OHV program be established in Tennessee with the goals of providing sufficient opportunities for the sport, propelling the associated economic benefits to the state, and properly managing OHV use to protect public safety, property owners, and natural resources.

The increase in the popularity of the sport and the decreasing opportunities for OHV recreation, make OHV management in the state of Tennessee a formidable task. Despite its growing popularity and apparent need for new management strategies, there is no published research devoted to modeling behavior or estimating the basic value of OHV recreation. Previous research efforts have looked at the economic impact of OHV recreation in addition to basic use estimates; however, no research has been devoted to economic modeling of the demand for OHV recreation.

The previous literature concerning OHV recreation is somewhat limited. No previous travel cost or contingent valuation studies have been performed on OHV recreation to our knowledge. Previous work has focused on other aspects of OHV recreation ranging from trail design to fuel use (e.g., Wernex 1993; Federal Highway Administration 1994).

The Tennessee Study Committee on Off-Highway Vehicles appointed the University of Tennessee to perform a survey of OHV users in 1999. This survey sought to gather information concerning opinions, user demographics, trip characteristics, motivations, and economic impact. Population estimates from this survey suggest that there are 553,000 OHV users in the state of Tennessee with 156,000 households containing at least one active user. Survey demographics reveal that the average OHV rider in Tennessee is a 38- to 44-year old white, male, with a high school degree and some college education. This representative individual earns between \$50,000 and \$74,999 per year (Fly et al. 2001). The annual economic impact of OHV activity in Tennessee was found to be \$3.6 billion (for fiscal year 2001). The total number of jobs affected by OHV recreation in Tennessee was found to be 52,300 (English et al. 2001a). The estimated economic impact of OHV special events was found to range from \$225,470 for the Dixie Run event to \$65,420 for the Appalachian Jeep Jamboree (English et al. 2001b). All economic impact estimates were generated using IMPLAN. Researchers considered expenditures incurred in preparing for, traveling to and from organized events and individual riding excursions. While these numbers exhibit the importance of OHV recreation to the state and local economy, they do little to supply information on OHV user behavior that is critical for proper OHV management.

Survey and Sampling Methodology

Data were collected using a combination of on-site, telephone, and mail surveys. Three subpopulations were identified and surveyed, including OHV special event participants, Tennessee sportsmen, and the general population. Event riders consisted of participants in four OHV special events. These events included the Dixie Run and the Appalachian Jeep Jamboree in the Nantahala National Forest of North Carolina, the Gateway to the Cumberlands in south-central Kentucky, and the VSTA off-road motorcycle event in Middle Tennessee. These respondents filled out a short on-site survey and were asked if they could be contacted in the future. Participants in the events who reside in Tennessee and agreed to be contacted were sent a mail survey. Of those 340 participants, 169 completed and returned mail surveys for a response rate of 49.7% (Fly et al. 2001).

Tennessee sportsmen interviewed during Fall 2000 Tennessee Wildlife Resources Agency (TWRA) hunting and fishing survey were asked if they owned or used an OHV for recreational purposes. Those who responded "yes" were asked if they could be contacted for a follow-up survey. A random sample of those agreeing to be contacted was selected to receive an OHV mail survey. Of those 587 sportsmen, 180 completed and returned mail surveys resulting in a response rate of 31.7% (Fly et al. 2001).

A randomly generated sample of Tennessee telephone numbers was purchased from Survey Sampling, Inc for the general population survey. The person answering the phone was asked if anyone in the household had driven or ridden an OHV in the past 12 months. If the response to this question was affirmative, the person administering the survey asked to speak with the primary OHV user in that household. Using Random Digit Dial (RDD), 721 households were contacted, and 411 interviews were completed by telephone for an RDD Telephone response rate of 57.0%. A follow-up mail survey was then sent to 158 OHV users identified in the RDD Telephone survey. Of those follow-up surveys, 60 were completed and returned for a 38.0% response rate (Fly et al. 2001).

Survey responses from the event surveys, the TWRA surveys, and the general population surveys were then aggregated. Out of the 409 surveys that were returned from all three survey procedures, 271 were usable. Because of significant differences in the costs experienced by the different OHV user groups, these 271 usable surveys were broken down by the type of OHV user. The three types of OHV users identified were off-highway motorcycle users (n=86), ATV users (n=89), and four-wheel drive users (n=96).

Travel Cost Method

OHV recreationist's (off-highway motorcycle, ATV, or four-wheel drive) choice of the number of visits to make to an OHV recreation site was modeled using an individual travel cost model. The utility structure was based on a number of factors. These included total time spent at the site, the quality of the site, and the quantity of visits. The individual solves the following utility maximization problem:

$$\text{Max: } u(X, r, q) \quad (1)$$

subject to the twin constraints of monetary and time budgets:

$$M + p_w * t_w = X + c * r \quad (2)$$

and
$$t^* = t_w + (t_1 + t_2)r \quad (3)$$

where X = the quantity of the numeraire whose price is one,
 r = the number of visits to the recreational site,
 q = environmental quality at the site,
 M = exogenous income,
 p_w = wage rate,
 c = monetary cost of a trip,
 t^* = total discretionary time,
 t_w = hours worked,
 t_1 = round trip travel,
 t_2 = time spent on site.

The monetary cost of a trip to an OHV site is composed of two parts: the admission fee f and the monetary cost of travel. Since most OHV recreation sites charge no admission, total cost in most instances was comprised of the monetary cost of travel (Freeman 1999). The costs of travel were split into five parts: lodging, food and beverage, transportation, off-highway vehicle expenses, and other expenses. Since OHV recreation requires substantial purchases to begin participation (high fixed costs) and it is reasonable to believe that these purchases may play a significant part in travel choice behavior, additional OHV expenditures were needed to supplement the marginal costs experienced by OHV users on each trip. Omitting these fixed costs could result in a model with very low explanatory power. Maximizing the utility maximization problem subject to (2) and (3) will yield the individual's demand function for visits:

$$r = r(p_r, M, q) \quad (4)$$

The data on rates of visitation and travel costs were used to estimate the coefficient on p_r in a travel cost-visitation function. The coefficient on p_r can then be used to derive the individual's demand for visits to a site (McConnell 1985).

Several assumptions were made in the previous model that required model specification. First, it was assumed that each trip to the site was for the sole purpose of visiting the site. If the purpose of the trip included other features or was made for another purpose in which the trip to

the OHV site was secondary, at least some of the travel cost would be a joint cost that could not technically be allocated to the cost of visiting the OHV site.

Another specification made from the basic model described above regards the measurement of travel time and the use of the wage rate as a shadow price for the relevant opportunity cost of time. Some researchers treat travel time as an endogenous variable (Shaw and Ozog 1999; Desvouges and Waters 1995). Others have included a proportion of the wage rate as an additional factor in the travel cost measurement (Randall 1994; Englin and Shonkwiler 1995). Recent research has led some to the conclusion that “the wage does not necessarily reveal anything about the shadow value of discretionary leisure time, either as an upper or lower bound.” (Larson, Shaikh, and Loomis 1997). While it is reasonable to believe that the travel cost of time could play a large part in trip choice behavior and in consumer surplus estimates, survey data limitations and questions about the validity of the wage rate as a shadow price for leisure time force the exclusion of costs associated with travel time in this study.

A Poisson model (travel cost model) can be used to calculate willingness to pay for access from the area under the expected demand function. The observed dependent variable was assumed to be random from a Poisson distribution with mean λ_i , where i represents the individual. In the Poisson model, all derivations were based on the expected demand function

$$E(X_i) = \lambda_i. \quad (5)$$

The value of access equals the area under the expected demand curve. For the exponential demand function, the choke price (C^*) is infinite. Assume a simple demand specification: $x = e^{\beta_0 + \beta_1 C}$ where C is the travel cost, and β_0 can be a constant or a function of covariates other than own price. For any finite C , $x = e^{\beta_0 + \beta_1 C} > 0$. Defining C^0 as the current travel cost, consumer surplus for access is

$$WTP = \left[(e^{\beta_0 + \beta_1 C}) / \beta_1 \right] = -x / \beta_1 \quad (6)$$

where x represents the number of trips taken by the individual and β_1 is the parameter estimate for travel costs. In the Poisson expression for sample mean WTP, one can use the mean of observed trips or mean of the expected trips because the Poisson model has the property that it is mean fitting (Haab and McConnell 2002).

RESULTS

OLS Regression

For the simple OLS regression of travel costs per trip it was assumed that the explanatory variables included natural log of the number of trips taken, experience in OHV recreation, age and education of individual, whether the individual is part of an OHV organization, and the natural log of the individual's income.¹ An individual's travel cost per trip was modeled as a function of these explanatory variables:

$$travel\ costs_i = \alpha + \sum \beta_j x_{ji} + u_i \quad (7)$$

¹ The variable on OHV group is a dummy variable where 1=member of an OHV organization, and 0=non-member

where j represents each variable, i represents the individual, and x is the value of each variable. This model was applied to off-highway motorcycle users, ATV users, and four-wheel drive users. This was done to isolate the differences in travel cost behavior between the user groups.

The OLS model was corrected for heteroskedasticity using White's correction (White 1980); the adjusted t-values represent the t-value obtained after correcting for heteroskedasticity. Adjusted probabilities were then calculated based on the adjusted t-values. A visual inspection of the tolerance levels revealed that multicollinearity between variables was minimal and had no significant effects on the model results.¹

The OLS results were very promising; with the model explaining nearly all of the variation in travel costs (modified R^2 ranged from .87 for four-wheel drive users to .90 for off-highway motorcycle users) and all of the explanatory variables significant and of the correct sign. Table 1 provides results of the OLS regression on all three user groups. For all user groups, the natural log of the number of trips taken was significant at the 5% level and had a negative influence on the amount of travel cost incurred by the individual. At first glance this seems to be a contradictory result. In most instances travel costs and number of trips tend to be directly related. However, it is important to note that equipment, insurance, and repairs were incorporated into the estimates for travel cost. These fixed or sunk costs will decrease the amount spent on each trip as the number of trips increases due to the nature of these costs. In other words, if an individual spent \$5,000 on a new ATV the effect of this sunk cost on the travel cost estimate will diminish as the individual engages in more OHV trips. The model, evaluated at the mean, estimated travel costs per trip around \$200 for all user groups.

Table 1. Results of OLS regression for travel costs.

Variable	Off-Highway Moto		ATV		4-Wheel Drive	
	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error
intercept	6.21148**	0.105	6.02787**	0.082	6.22119**	0.101
lntrips	-0.33786**	0.013	-0.28975**	0.011	-0.34554**	0.015
exp	0.00175	0.001	0.0001199	0.001	-0.00195	0.001
age	-0.00141	0.002	-0.0001928	0.001	0.00126	0.001
edu	0.01539	0.010	-0.00491	0.007	0.00304	0.010
ohvgrp	-0.02076	0.043	-0.0161	0.022	-0.03848	0.030
lninc	-0.00224	0.050	0.05619*	0.030	0.02852	0.044

*significant at the 5% level of probability

** significant at the 1% level of probability

In two of the models, the natural log of income was found to be highly insignificant for prediction of travel costs. In the ATV model, the coefficient for income was highly significant. This would lead one to conclude that an increase in income for ATV users would lead to a greater amount of travel costs incurred; therefore making income and travel costs more elastic in comparison to the other two user groups. The income elasticities revealed this exact trend. The income elasticity of the ATV user groups was found to be 1.02 compared to 1.01 and 0.99 for the four-wheel drive and off-highway motorcycle groups respectively.

¹ Tolerance levels were all found to be greater than 0.60.

Poisson Model

A Poisson model is used in a standard travel cost application by modeling the number of trips taken based on travel costs and a number of other variables. These variables include

- dummy variable to determine private or public land rider (pubrider),
- amount of OHV experience (exp),
- dummy variable to gauge satisfaction with OHV opportunities (ohvopp),
- dummy variable to determine approval of OHV management (ohvmng),
- respondent's age,
- respondent's education level,
- whether the respondent is a member of an OHV group, and
- respondent's income.

The standard travel cost model is modified slightly by taking the natural log of the number of trips taken to remedy the effects of a standard error greater than the mean for this variable. The range of trips taken was 1 to 120 with the average number of trips estimated at about 23. The number of OHV trips an individual takes in Tennessee was modeled in the following way:

$$\text{number of OHV trips}_i = e^{(\alpha + \sum \beta_{ji}x_{ji} + u_i)} \quad (8)$$

Once again this same model was duplicated for the three different user groups to identify differences in trip taking behavior between the three groups.

The results of the Poisson regression for the three user groups revealed that the model fit the data extremely well (scaled Pearson chi-square ranged from 76 to 86).¹ Model results revealed that travel costs were significant at the 5% level in all models. As expected, travel costs negatively influenced the number of OHV trips taken. The travel cost coefficient implies that a one-dollar increase in the cost of an OHV trip in Tennessee results in a 0.05% to 0.06% decrease in the number of trips. This is small, but not surprising in this case given the limited number of substitute sites. The choke price, or the price at which no OHV trips will take place, was estimated to be around \$400 for all user groups. WTP per trip ranged from \$169 for the ATV user group to \$200 for the off-highway motorcycle user group. Poisson regression results can be found in Table 2.

¹ The original Pearson Chi-Square for the three groups was estimated from 1.7 to 2.1 showing that a great deal of over-dispersion was present in the model

Table 2. Results of Poisson regression for travel costs.

Variable	Off-Highway Moto		ATV		4-Wheel Drive	
	Coefficient	Std Error	Coefficient	Std Error	Coefficient	Std Error
intercept	1.9956**	0.081	2.2075**	0.076	2.0704**	0.071
tc	-0.005**	0.000	-0.0059**	0.000	-0.0056**	0.000
pubrider	-0.0132	0.023	-0.0077	0.020	0.0267	0.021
exp	0.0028*	0.001	-0.0002	0.001	-0.0008	0.001
ohvopp	0.059	0.033	-0.0327	0.030	0.0341	0.025
ohvmng	-0.0383	0.044	-0.0057	0.033	-0.0695*	0.030
age	-0.0011	0.002	-0.0006	0.001	0.0006	0.001
edu	0.0168	0.009	-0.0063	0.007	0.0078	0.007
ohvgrp	0.0116	0.044	-0.0146	0.024	-0.0237	0.023
inc	-0.0125	0.009	0.0078	0.006	0.0026	0.007

*significant at the 5% level of probability

** significant at the 1% level of probability

The income elasticity of demand for the off-highway motorcycle user group was estimated to be -0.090 , suggesting that the demand for trips is an inferior good. In other words, as the income of a specific individual increased by 10%, that individual's demand for off-highway motorcycle trips decreased by .90%. Several prior studies have revealed that as income increases the number of recreational trips increases producing positive income elasticities. This leads us to believe that off-highway motorcycle recreation would be dropped for other forms of recreation as income increases. The income elasticity of demand for the other user groups was positive and ranged from 0.017 to 0.055. As expected, the price elasticity of demand was found to be negative and highly responsive to travel costs. Specifically, as the price of an OHV trip increased by 10%, the demand for these trips decreased from 11.4% to 12.8%.

CONCLUSIONS

This paper provides the only estimates of a model of the demand for OHV recreation. Travel cost spending behavior for OHV trips appeared normal. Specifically, the variable on trips was found to be significant and the income elasticity ranged from 0.99 to 1.02. For recreational pursuits that involve a great deal of fixed costs to participate, the predicted travel costs decrease as the number of trips increases. This is reverse of the behavior found in other forms of recreation (hiking, swimming, fishing) that require relatively small fixed costs to participate. Individual mean WTP per trip was found to range between \$170 and \$200 with off-highway motorcycle users exhibiting the largest consumer surplus and ATV users the smallest. Preliminary analysis reveals that off-highway motorcycle recreation may be viewed as an inferior good. This form of recreation may be a less costly alternative for OHV participants. Income elasticities exhibited an inelastic relationship between income and the number of OHV trips but an elastic relationship between price and the number of OHV trips. These data could be useful to land managers who may wish to limit OHV use by instituting a user fee. It also provides insight into the possible decreases in OHV user rates as a result of any OHV user fee as a part of a statewide OHV management plan.

While these numbers are useful as the first model estimates of OHV recreation, it is important to pinpoint possible sources of bias. Due to survey information limitations, substitute prices and quality as well as travel and on-site time were ignored in this analysis. The omission of substitute prices will bias the WTP estimate upwards as well as affecting estimates of price elasticity. If the correlation between the two travel cost variables is positive, then omitting the substitute prices biases the own price elasticity toward zero. But if the two travel costs are inversely correlated, the estimated own price coefficient is subject to a negative bias and the price elasticity of demand for visits is biased upwards. While it is reasonable to assume that the effect of substitutes is relatively small for OHV recreation, this could be the source of possible bias. In most cases, ignoring travel and on-site time leads to much lower benefit estimates. Due to these survey data limitations and misspecifications, more regional studies should be performed. Until these areas are improved upon, this study contains one of the few if not the only available estimates of the benefits of OHV recreation.

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The Economic Impact of the Proposed Marvin Nichols I Reservoir to the Northeast Texas Forest Industry

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Abstract: This study assessed the economic impact of the potential reduction of timber supply to the local forest industry and the local economy from a proposed reservoir in Northeast Texas --- Marvin Nichols I Reservoir. The study first evaluated the forested acres at the reservoir site and those under habitat mitigation requirements, providing a foundation for timber supply impact assessment. Then, the timber supply impact in terms of the lost timber volume and value was estimated. Finally, the direct and total economic impacts of the reservoir to the local forest industry and the local economy were assessed using input-output method. The study found that the forest industry and the local economy would incur significant losses due to the substantial reduction in timber supply from the reservoir project. Furthermore, the economic impact of the reservoir would likely be uneven in the region. The manufacturing facilities and the communities that are dependent on hardwood resources near the reservoir site or the mitigation management areas would probably be impacted the most. The magnitude of the total impact will be primarily dependent upon the amount of forest acres set aside for mitigation wildlife habitat requirements.

Key Words: habitat mitigation requirements, timber supply, economic impact assessment

INTRODUCTION

The proposed Marvin Nichols I Reservoir is in Red River, Titus, Morris, Franklin, and Bowie counties, on the main stem of the Sulphur River in Northeast Texas. The proposed dam site is approximately 17 miles northeast of Mount Pleasant, Texas (NERWPG, 2001). Bottomland hardwood and other forest types at the reservoir site will be affected after the establishment of the reservoir. In addition to the loss of timber in the reservoir itself, federal and state regulations require that the lost wildlife habitats in the reservoir must be fully offset by managing habitats of similar qualities elsewhere (habitat mitigation requirements). The affected forests on the reservoir site and the management restrictions on the forests used for habitat mitigation will reduce timber supply in the area, impacting the local forest industry.

The purpose of this study was to assess the economic impact of the potential reduction of timber supply to the local forest industry and the local economy. The study first evaluated the forested acres at the reservoir site and those under mitigation requirements, providing a foundation for timber supply impact assessment. Then, the timber supply impact in terms of the lost timber volume and value was estimated. Finally, the direct and total economic impacts of the reservoir to the local forest industry and the local economy were assessed.

FORESTLAND AFFECTED

According to a recent study by the Texas Parks and Wildlife Department (Liu et al. 1997), the total area of the Marvin Nichols I Reservoir in the conservation pool (at 312 feet) is 67,957 acres. The forested area in the conservation pool includes 36,178 acres of bottomland hardwood and 19,453 acres of upland hardwood. In addition, there are 4,735 acres of bottomland hardwood and 10,662 acres of upland hardwood in the flood pool of the reservoir

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(between the mean [312 feet] and maximum [322.5 feet] pool levels). Sub-forest types are combined for simplicity. The rest of the proposed reservoir area consists of water, grassland, crops/managed grassland and bare land.

According to Liu, et al. (1997), species commonly found in the bottomland hardwood area of the proposed reservoir include water oak, willow oak, blackgum, American elm, overcup oak, green ash, deciduous holly, sugarberry, boxelder, American hornbeam, willow and river birch. Species commonly found in the upland hardwood area include post oak, black hickory, blackjack oak, and winged elm, etc.

In addition to the forestland at the reservoir site, a certain amount of forestland of similar quality must be acquired elsewhere and intensively managed for wildlife habitats to fully compensate for the lost habitats due to the reservoir. In this study, the mitigation acres were estimated using a method described in Frye and Curtis (1990) in conjunction with the latest available information on the forested acres of the reservoir from the Texas Parks and Wildlife Department (Liu et al., 1997). Frye and Curtis used a habitat quality (HQ) score to convert the lost forested areas into habitat units lost. Then the mitigation acres were derived based on the potential HQ gain under different management intensities for wildlife habitats. It was assumed that the habitat quality of the land used for mitigation would be the same as the HQ in the forests in the reservoir. In the absence of detailed information about the water dynamics in the flood pool and the habitat characteristics, it was assumed that the effect on the habitat in the flood pool would be neutral and no habitat mitigation would be needed for the flood pool. According to our estimation, the mitigation acres for a total HQ gain of 25%, 50% or 100% under a minimum, moderate or maximum habitat management option correspond to 13.5, 6.7 and 3.4 times the forest acres lost in the conservation pool of the reservoir, respectively (Table 1)ⁱ.

Table 1. Forestland affected by the proposed Marvin Nichols I Reservoir and its mitigation requirements

Requirements									
Forest Type	Conser- vation Pool (Acre)	Habitat Quality (HQ) Score	Habitat Units Lost	Management Option	Potential HQ Gain	Compensation Requirements (Acre)	Flood Pool (Acre)	Total Acres Affected	
[1]	[2]	[3]	[4]= [2]x[3]	[5]	[6]	[7]= 1-[3]]x[6]	[8]=[4]/[7]	[9]	[10]= [2]+[8]+[9]
Bottomland	36,178	0.81	29,304	Minimum	25%	0.048	616,922	4,735	657,834
Hardwood				Moderate	50%	0.095	308,461		349,374
				Maximum	100%	0.190	154,230		195,143
Upland	19,453	0.63	12,255	Minimum	25%	0.093	132,489	10,662	162,604
Hardwood				Moderate	50%	0.185	66,245		96,359
				Maximum	100%	0.370	33,122		63,237
Total	55,631		41,559	Minimum	25%		749,411	15,397	820,439
Forestland				Moderate	50%		374,705		445,733
				Maximum	100%		187,353		258,380
Non-forested Land	12,326							75,984	
Total	67,957							91,381	

Timber Supply Impact

The proposed reservoir will reduce the short-term and long-term timber supply in the local area due to construction of the reservoir and the restrictions on timber harvesting in the mitigation management areas, assuming all mitigation management areas for the reservoir are located in Northeast Texas, a 21-county area.

The potential short-term loss of timber from the reservoir site is somewhat straightforward. The available timber in the forested area of the proposed reservoir in the conservation pool will be lost permanently. The forests in the flood pool will be subject to regular flooding and to harvest restrictions protecting water quality and wildlife habitats. The loss of long-term timber supply will be substantial due to the flooding and harvest restrictions. In addition, the flood pool will probably become public property to protect the reservoir, making it even less available for commercial timber production. All of these outcomes suggest that we can expect no long-term timber supply from the flood pool of the reservoir.

The potential loss of timber supply due to the mitigation management requirements for the conservation pool is not immediately clear. The exact locations of the mitigation management areas for the reservoir have not been determined and the forests that would be affected are not known. This leaves future management of the mitigation lands largely unknown. However, since the general forest types in the proposed reservoir area are bottomland hardwood and upland hardwood forests, areas with similar forest types currently managed for wildlife

habitat provide useful information on the forest management characteristics of the proposed reservoir area. For this reason, several management plans for wildlife management areas (WMA) in Texas managed by Texas Park and Wildlife Department were reviewed¹¹. While each WMA has its own management prescription specific to the wildlife habitat requirements, these plans share some common characteristics with timber harvesting. First, timber harvesting, especially commercial timber harvesting is not a goal but merely a byproduct of wildlife management. It is possible that it may never be necessary to harvest timber in such areas. The primary goal of WMAs is optimization of wildlife habitat. Secondly, while timber harvesting is not prohibited, it has historically been minimal on these types of lands. The rotation length on timber in wildlife management areas is substantially longer than on commercial timberlands, when, or if, timber is ever harvested. The timber is never completely removed from a WMA because some trees are left as snags and woody debris for wildlife habitat.

If the management styles of the reservoir mitigation management areas are consistent with that of the WMAs currently managed by the Texas Parks and Wildlife Department, any timber supply from the reservoir mitigation management areas would likely be unreliable at best. The reservoir mitigation management areas would not be sources for sustainable industrial timber supply. Because of this, it was assumed in this study that there would be no timber supply from the mitigation management areas of the Marvin Nichols I Reservoir.

The loss of the long-term timber supply, defined as the loss of long-term industrial roundwood supply in this study, equals the loss of the long-term average growth of the forests. The loss of long-term industrial roundwood supply can be estimated by applying the average annual growth rates of roundwood per acre to the total affected forested acres at the reservoir site and in the mitigation management areas. The average growth rates of industrial roundwood can be estimated using the average growth rates of the growing stock and the proportion of industrial roundwood to the growing stock. Assuming the average growth rates for bottomland and upland hardwood growing stock in Northeast Texas are 47.1 and 38.6 cubic feet/acre/year, respectively (Rosson, 2000) and 78.7% of the hardwood growing stock is industrial roundwood in East Texas (Xu, 2000), the average growth rates of industrial roundwood in the bottomland and upland hardwood forests for Northeast Texas are 37.1 cubic feet/acre/year ($47.1 \times 78.7\%$) and 30.4 cubic feet/acre/year ($38.6 \times 78.7\%$), respectively.

The estimated annual loss of timber supply under the minimum management option will be 29.33 million cubic feet (the product of the growth rate of industrial roundwood derived in the above and the total loss of acres estimated in the previous section). If moderate management were used, the estimated annual loss of timber supply would be reduced to 15.88 million cubic feet. Under the maximum management option, the estimated annual loss of the timber supply would be 9.16 million cubic feet, about one-third of the losses sustained under the minimum management option. The impact is bigger for the minimum habitat management option than the maximum management option. This is because less habitat gain per acre would be created to meet the required compensation under the minimum management option, and thus more forested acres would be designated for habitat mitigation management instead of timber management. With an annual production of hardwood roundwood from Northeast Texas at 91.09 million cubic feet per year (Xu, 2000), this loss of timber supply would account for 32.2% of the total hardwood roundwood production in the Northeast Texas region under the minimum management option (17.4% if under moderate management and 10.1% if under maximum management).

The annual losses of timber supply were estimated to be 2.37-7.60 million cubic feet per year for sawlog roundwood and 6.79-21.74 million cubic feet per year for pulpwood roundwood

depending on the habitat management options (Table 2). Sawlogs accounted for 25.9% of roundwood and pulpwood accounted for 74.1% of roundwood in Northeast Texas (Xu, 2000).

Next, the annual loss of the timber value was estimated by using the average timber prices (weighted stumpage prices and delivered prices) and the total loss of volume for sawlogs and pulpwood. Using the average stumpage price of \$0.61/cubic foot (hardwood sawlogs) and \$0.15/cubic foot (hardwood pulpwood) for Northeast Texas in 1999 (Xu, 2000), the estimated annual loss of timber values would range from \$2.49 to \$7.97 million dollars depending on the management options utilized. At the delivered price of \$1.17/cubic foot (hardwood sawlogs) and \$0.69/cubic foot (hardwood pulpwood) in the region in 1999 (Xu, 2000), the estimated annual loss of timber values would rise to \$7.5-23.9 million depending on the management options used. Detailed estimates of the losses by wood type (sawlogs and pulpwood) and management options are illustrated in Table 2.

Table 2. Annual timber volume and value lost in the reservoir and mitigation areas

Forest Type	Management Option	Roundwood (mmcf/yr)			Stumpage (mm\$/yr)			Value Delivered Value (mm\$/yr)		
		Total	Sawlog	Pulpwood	Total	Sawlog	Pulpwood	Total	Sawlog	Pulpwood
Bottomland Hardwood	Minimum 25%	24.39	6.32	18.07	6.63	3.86	2.76	19.88	7.37	12.51
	Moderate 50%	12.95	3.36	9.60	3.52	2.05	1.47	10.56	3.91	6.65
	Maximum 100%	7.24	1.87	5.36	1.97	1.15	0.82	5.90	2.19	3.71
Upland Hardwood	Minimum 25%	4.94	1.28	3.66	1.34	0.78	0.56	4.03	1.49	2.53
	Moderate 50%	2.93	0.76	2.17	0.80	0.46	0.33	2.39	0.88	1.50
	Maximum 100%	1.92	0.50	1.42	0.52	0.30	0.22	1.57	0.58	0.99
Total	Minimum 25%	29.33	7.60	21.74	7.97	4.64	3.32	23.91	8.86	15.05
	Moderate 50%	15.88	4.11	11.77	4.32	2.51	1.80	12.95	4.80	8.15
	Maximum 100%	9.16	2.37	6.79	2.49	1.45	1.04	7.46	2.77	4.70

METHODS FOR ECONOMIC IMPACT

The economic impact of the Marvin Nichols I Reservoir project to the local forest industry was estimated using the input-output method. This method is designed to measure the interdependencies of industries in the economy by relating the impact of changes of economic activities in one sector of the economy to those of other sectors of the economy. The IMPLAN system, a computerized input-output modeling system, and associated databases from the Minnesota IMPLAN Group (MIG) were utilized in this study. The data set used in this study was for 1999. All values estimated here were in 1999 dollars.

In the model, the Northeast Texas economy is divided into seventeen sectors, including agriculture, mining, construction, six forest industry sectors (forestry, logging, primary solid wood products, secondary solid wood products, primary paper & paperboard products, and secondary paper & paperboard products, other manufacturing, transportation, communication and utility, trade, banking and insurance, residential housing and real estate, services, government, and others.

This study assumed that the timber supply reduction due to the reservoir project would not change the current import/export ratio of timber in the region. It assumed then that the direct industry outputs of the six forest industry sectors would decrease proportionally to the lost timber values from the reservoir project (Table 3). The types of timber values used here differ by forest Table 3. Potential lost outputs in northeast Texas caused by the reservoir project

Note:

¹Found in Table 2.

Sector	Management Option			Calculation of the Ratios
	Minimum	Moderate	Maximum	
Forestry	3.72%	2.02%	1.16%	Total stumpage value lost ¹ / total stumpage value in 1999 in NE TX ²
Logging	6.13%	3.32%	1.92%	Total delivered value lost ¹ / total delivered value in 1999 in NE TX ³
Primary Solid Wood Products	3.30%	1.78%	1.03%	Total sawlog delivered value lost ¹ / total sawlog delivered value of 1999 in NE TX ⁴
Secondary Solid Wood Products	3.30%	1.78%	1.03%	Total sawlog delivered value lost ¹ / total sawlog delivered value of 1999 in NE TX ⁴
Primary Paper & Paperboard Products	12.46%	6.74%	3.89%	Total pulpwood delivered value lost ¹ / total pulpwood delivered value of 1999 in NE TX ⁵
Secondary Paper & Paperboard Products	12.46%	6.74%	3.89%	Total pulpwood delivered value lost ¹ / total pulpwood delivered value of 1999 in NE TX ⁵

²The total stumpage value of Northeast Texas in 1999 was \$214 million (Xu, 2000)

³The total delivered value of Northeast Texas in 1999 was \$390 million (Xu, 2000)

⁴The total sawlog delivered value of Northeast Texas in 1999 was \$269 million (Xu, 2000)

⁵The total pulpwood delivered value of Northeast Texas in 1999 was \$121 million (Xu, 2000)

industry sector. For the forestry sector, timber stumpage value was used because it accounts for the majority of the sector's output. For the same reason, delivered value of the timber was used for the logging sector. Delivered value of the sawlogs was used for the primary and secondary solid wood products sectors because delivered sawlogs are the primary wood raw material for the sectors, directly or indirectly. Similarly, the delivered value of pulpwood was used for the primary and secondary paper & paperboard products sectors. For example, the reduced output from the forestry sector was calculated using the following formula:

Reduced Output = Total output of the forestry sector in NE TX in 1999 * (Total stumpage value lost / Total stumpage value in NE TX in 1999)

This study used the output reduction of the six forest industry sectors (as "events" in the input-output model) caused by the reduction of timber supply to estimate the direct and total economic impacts of the reservoir to the forest industry sector. In addition, to avoid double-counting of the estimated economic impacts, the regional purchasing coefficients, an inter-sector linkage factor in the model, for forestry, logging, primary solid wood products, and primary paper & paperboard products were assumed to be zero.

The total economic impacts of the output reductions of the six forest industry sectors due to construction of the reservoir were estimated by industry output, value-added, employment and labor income. Included in the total economic impacts were the direct effects of the reservoir on the forest industry, the indirect effects of other sectors impacted by the forest industry's reduced

purchases of goods and services, and induced effects of reduced consumption of goods and services because of the decreased incomes from the direct and indirect effects (MIG, 2002).

RESULTS OF ECONOMIC IMPACT ANALYSIS

Twenty-one counties in the Northeast Texas region have 15,056 square miles of land and 993,287 people in 374,264 households (MIG, 2002). In 1999, the region produced \$45.2 billion of industry outputs, \$24.2 billion of which were value-added. The total employment in the region was 523,735 and the total payroll (wages/salaries/benefits) amounted to \$15.3 billion in the same year. The Northeast Texas region has 5.07 million acres of timberland, of which 1.42 million acres are pine forests, 1.04 million acres are pine oak mixed forests, 1.76 million acres are upland hardwood forests, and 0.85 million acres are bottomland hardwood forests (Rosson, 2000). In 1999, the region produced 236.6 million cubic feet of softwood and 94.5 million cubic feet of hardwood (Xu, 2000). The forest industry (the six forest industry sectors) in Northeast Texas accounted for 12.6% of the total industry output, 14.1% of the total value-added, 15.2% of the total employment and 12.6% of the total labor income from all manufacturing sectors in the region in 1999.

The proposed Marvin Nichols I Reservoir project will have significant economic impact to the local forestry industry and the economy. Under the minimum management option for the mitigation area, the forest industry of Northeast Texas would suffer an annual loss of \$98.71 million in industry output, approximately 6.1% of the total Northeast Texas regional forest industry output in 1999. The industry would also lose \$32.94 million value-added, 514 jobs, and \$18.73 million labor income per year. Under the same management option, the total impact (direct, indirect, and induced effects) to the local economy (all seventeen economic sectors) in the region would be an annual loss of \$163.91 million industry output, \$70.10 million value-added, 1334 jobs, and \$41.4 million labor income.

Under the moderate management option for the mitigation management areas, the reservoir project would reduce the local forest industry's annual output by \$53.44 million (3.3% of the total forest industry output of the region) and value-added by \$17.83 million per year. The local forest industry would also lose 278 jobs and cut \$10.14 million in payroll. The local economy as a whole was estimated to lose \$88.74 million in output, \$37.96 million in value-added, 722 jobs and \$22.42 million in labor income annually.

As expected, the maximum habitat management option for the mitigation management areas of the proposed reservoir would cause less economic impact to the forest industry and the local economy than the previous two scenarios. The impact of the proposed reservoir to the local forest industry under this management option is a decrease of \$30.82 million in industry output (1.9% of the total forest industry output in the region in 1999), \$10.28 million of which are value-added. It would reduce 160 jobs and \$5.85 million payroll in the forest industry. The total economic impact of the project is estimated to be a reduction of \$51.18 million output, \$21.89 million value-added, 417 jobs, and \$12.93 million labor income (Table 4).

Table 4. Direct and total economic impacts of the reservoir project to the Forest Industry in Northeast Texas by Management Option

Habitat Management Option	Output (million \$)	Value-Added (million \$)	Employment	Labor Income (million \$)
Direct Economic Impact				
Minimum	98.71	32.94	514	18.73
Moderate	53.44	17.83	278	10.14
Maximum	30.82	10.28	160	5.85
Total Economic Impact				
Minimum	163.91	70.10	1,334	41.40
Moderate	88.74	37.96	722	22.42
Maximum	51.18	21.89	417	12.93

SUMMARY AND DISCUSSION

This study analyzed the direct and total economic impacts of the proposed Marvin Nichols I Reservoir to the forest industry and the overall economy of Northeast Texas. According to the analysis, the forest industry is an important economic sector in the region. The forest industry and the local economy would incur significant losses due to the substantial reduction in timber supply from the reservoir project. Furthermore, the economic impact of the reservoir would likely be uneven in the region. The manufacturing facilities and the communities that are dependent on hardwood resources near the reservoir site or the mitigation management areas would probably be impacted the most.

The magnitude of the impact will be primarily dependent upon the amount of forest acres set aside for mitigation requirements. The impact analysis in this study was based on three hypothetical mitigation management scenarios for wildlife habitat in the mitigation management areas. The economic impact of the reservoir project varied substantially among the three scenarios. Higher management intensity for wildlife habitat in the mitigation management area would mean higher habitat quality gain per acre and fewer acres needed for meeting the mitigation requirements. This would result in lower negative economic impact to the forest industry and the local economy. However, the higher habitat quality gain per acre through this intensive management would be more costly and take a longer time.

Caveats: first, this study used the best available information about the size, land classification and habitat quality of the Marvin Nichols I Reservoir. The detailed environmental impact assessment of the reservoir, which would contain detailed accurate information about the quantity and quality of the wildlife habitat on the reservoir site, was not yet available at the time of this study. Second, the study did not address the potential impacts of the reservoir to the economic activities inside of the Northeast Texas region that were not directly related to the forest industry in the region, nor did it reflect impacts to the economies outside of the region. Third, the linkage between timber supply to the primary forest industry is stronger than that to the secondary forest industry. Secondary forest industry does not use timber as raw material directly but rather wood products from the primary forest industry, which are less costly to transport from other regions than timber. Therefore, the economic impact estimates are likely to be more accurate for forestry, logging, primary solid wood products and primary paper &

paperboard products sectors than for secondary solid wood products and secondary paper & paperboard products sectors.

ENDNOTES:

- i. See Frye and Curtis (1990) for detailed methods for mitigation requirement estimation.
- ii. The management plans for the wildlife management areas that have been reviewed include Old Sabine Bottom Wildlife Management Area, White Oak Creek Wildlife Management Area, Richland Creek Wildlife Management Area, and Gus Engeling Wildlife Management Area.

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Effect of Stochastic Prices on Intensive Management Treatment Scenarios and Collective Harvesting Decision by NIPF Landowners.

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Abstract: This study evaluates the possibility of strategic behavior of forest landowners with regard of the intensity of forest management. We relax the general assumption for a competitive market that the marginal decisions of agents in the market do not affect future market prices. We assume that forest landowners realize that information about future price trends, which encourages certain forest management strategies to increase/decrease silvicultural intensity, will also encourage other landowners to follow in similar fashion. This will result in an aggregation of individual harvest yields and unexpected changes in supply and, as a result, future prices. Forest landowners are thus behaving as Cournot agents and market equilibrium is reached through asymptotic Cobweb output cycles. We hypothesize that market efficiency will be achieved and benefits realized by some forest landowners from changing their behavior to that of a Stackelberg leader or follower in sawtimber output markets.

Nonstationarity and Its Consequences in Modeling the Southern Timber Market

Nianfu Song¹ and Sun Joseph Chang¹

Abstract: This paper uses the Augmented Dickey-Fuller test to examine time series data of the southern timber market. Results indicate that nonstationary time series exist widely in timber market data. Econometric models estimated with such data are invalid and misleading. Examples show that level data timber market models are quite possibly misleading. Most existing models for the southern timber market are likely to overestimate model coefficients and need to be reevaluated in light of stationarity and corrected for further application.

Key Words: integrated process, time series, unit root test, harvest, timber price.

INTRODUCTION

Over the past 50 years, forests in the South have become increasingly important, in part because of their high productivity and because of laws that reduced production of timber on public land. This rich forestland has the potential for producing significant timber volume within a relatively small area. As a result of both government actions and favorable market conditions, timber production in the South has been increasing. For example, softwood timber production increased over 100 percent in 31 years from 1966-1996 (Figure 1). During the same period, inventory of softwood increased 28 percent (Figure 2), and harvest rate increased 53 percent (Figure 3). Softwood harvest by the forest industry had increased 232% while that by other private forest owners had increased 53%.

Based on these records, forest researchers conducted econometric studies to analyze and explain the change process (Adams et al., 1986, Newman, 1987, Lee et al., 1992). Recent development in econometrics, however, found that nonstationarity should be corrected before conducting a regression. A nonstationary variable is a time series whose mean or variance changes with time. If the differences of a series are stationary, then such a series is called integrated variables. With nonstationary time series, results from traditional econometric techniques such as OLS, 2SLS, 3SLS, ARMA are misleading (Greene 2002, pp. 631-649) and invalid, "causing erroneous specifications to be adopted" (Kennedy 1998, pp. 263-269). The conventional t and F tests would tend to reject the hypothesis of no relationship, erroneously suggesting the existence of a relationship when there is none. If aggregate data series for the southern timber market such as timber harvest, forest inventory, and planting areas that exhibit upward trends are indeed nonstationary, then all models that ignored this should be re-evaluated. Because nonstationarity has not received sufficient attention in modeling the timber market, this provides a fresh opportunity to re-examine past modeling efforts, now that new methods for correcting nonstationarity are available.

Existing models for timber markets in the US have paid little attention to nonstationarity. Typically, these models are estimated using level time series that may be nonstationary. Early in

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Acknowledgement: We would like to thank Professor Darius M. Adams at Oregon State University for kindly allowing us to use his data for TAMM model. His suggestion on correcting nonstationary error term gave us the idea to check for stationarity of data series for southern timber market and investigate the consequences of including nonstationary variables in timber market models.

Approved for publication by the Director of Louisiana Agricultural Experiment Station as manuscript 03-40-1284.

1986, Adams, McCarl, and Homayounfarrokhi (1986) found that “first difference form avoids serious problems of serial correlation in the undifferenced data.” The autoregressive problem was probably caused by nonstationarity, but there was no discussion about such data problems in the paper. Most models of the southern timber market assume stationary error terms and ignore problems in them. Some models (Cohen, 1983, Lee et al., 1992) directly apply OLS to time series of forests in the South. Newman’s 3SLS model (Newman 1987) on southern softwood stumpage market had serious autocorrelation problems with DW around 1.0. Such autocorrelation may be the result of nonstationary data (Greene, 2002, pp. 631-646). In fact, the value of DW is also erroneous when data are nonstationary (Kennedy 1998, pp. 263). Other models use MLE and do not check for the error terms (Hyberg and Holthausen, 1989). It would be well advised to account for nonstationarity in the data series during model estimation.

Early models for other parts of the US and other countries often failed to address nonstationarity in data as well. The reported DWs in the Constatino and Tonwsend’s models (1989) are far from 2. Some are as small as 0.38, and others are as large as 2.48. While modeling the paper demand in the United States, Zhang and Buongiorno (1997) estimated their SUR (Seemingly Unrelated Regression) models with the first differences of communication media data to remove autocorrelation, similar to what Adams et al. did in 1986. But for the demand models of papers, they applied level data, and the DWs for those models ranged from 1.18 to 1.80. In a paper on Quebec-Ontario-U.S. Northeast softwood timber markets, Bernard and others (1997) estimated their model with iterated nonlinear three-stage least squares method (INL3SLS). Although the plotted series in the paper are obviously trending upward the possible nonstationarity of the series were ignored. In Europe, however, nonstationarity has caught the attention of researchers. A study of the pulpwood market (Nyrud, 2002) treats integrated data with cointegration when unit root tests reveal the existence of nonstationarity.

Nonstationarity of Harvest and Inventory Data in the South

Graphically, we can see that historical harvest and inventory (Figure 1 and 2) are changing over time. These changes over time are typical characteristics of nonstationarity. Models with levels of these timber market series are likely to violate the stationarity assumption of the traditional econometric analyses.

Softwood timber produced (Figure 1) by forest industry in the Southcentral sub-region (HSCFI), softwood timber produced by the other private in the Southcentral sub-region (HSCOP), and softwood timber produced by forest industry in the Southeast sub-region (HSEFI) are obviously changing over time. Econometrically, they are all possibly nonstationary time series.

Inventories of the forest industry and other private forest owners in these sub-regions are also changing with time (Figure 2). Inventories by the other private forest owners have a more pronounced trend than those of the forest industry.

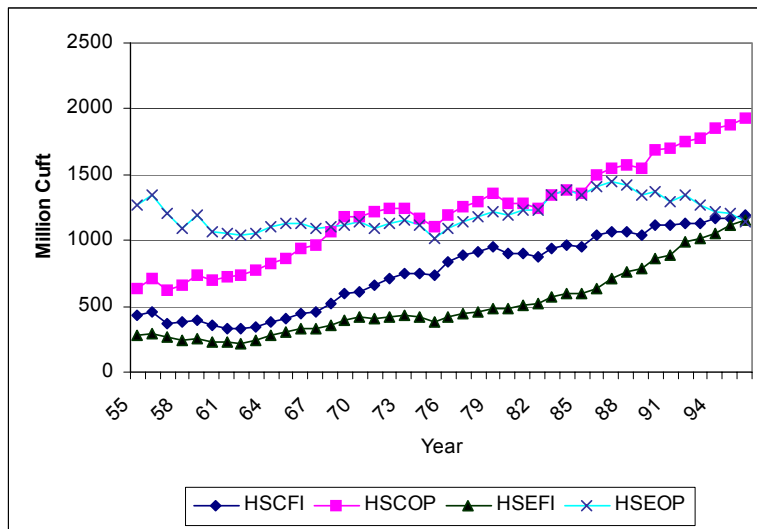


Figure 1 Softwood Harvest of U.S. South

Note:HSCFI: softwood harvest of the forest industry in Southcentral sub-region;
HSEFI : softwood harvest of the forest industry in Southeast sub-region;
HSCOP:softwood harvest of the other private in Southcentral sub-region;
HSEOP:softwood harvest of the other private in Southeast sub-region.

Data source: TAMM model, Darius M. Adams, Oregon State University

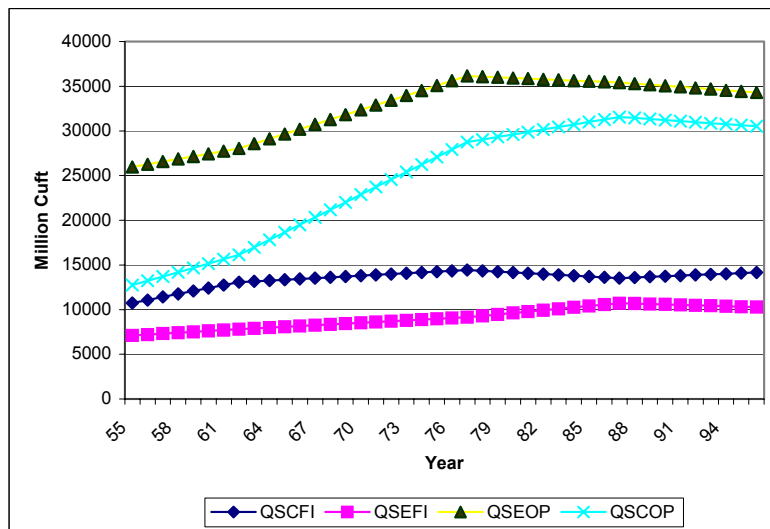


Figure 2 Interpolated Inventory of U.S. South

Note: QSCFI : softwood inventory of the forest industry in Southcentral sub-region;

QSEFI : softwood inventory of the forest industry in Southeast sub-region

QSCOP:softwood inventory of the other private in Southcentral sub-region;

QSEOP:softwood inventory of the other private in Southeast sub-region.

Data source: TAMM model, Darius M. Adams, Oregon State University

Figure 3 shows the harvest ratios for different ownerships in the two sub-regions in the South. The harvest ratios are also likely to be time trended. Harvest volumes are parts of the inventory before harvest. So the harvest ratio should be calculated as $\text{harvest}/(\text{pre-harvest inventory})$. $\text{HSCFI}/\text{QSCFI}(-1)$, $\text{HSEFI}/\text{QSEFI}(-1)$, $\text{HSCOP}/\text{QSCOP}(-1)$, $\text{HSEOP}/\text{QSEOP}(-1)$ are, respectively, the harvest ratios of the forest industry in the Southcentral, the forest industry in the Southeast, the other private forest owners in the Southcentral, and the private forest owners in the Southeast. $\text{QSCFI}(-1)$, $\text{QSEFI}(-1)$, $\text{QSCOP}(-1)$, and $\text{QSEOP}(-1)$ are the pre-harvest inventories for the four types of forests. All four ratios are trending upward and probably autoregressive for most of the years. Forest industrial harvests ratios exhibit more obvious trends than other private harvest ratios. The harvest ratio of the whole South ($\text{H}/\text{Q}(-1)$) is also a time trend series. Here H is the harvest of softwood timber of the South and $\text{Q}(-1)$ is the total pre-harvest inventory of the South.

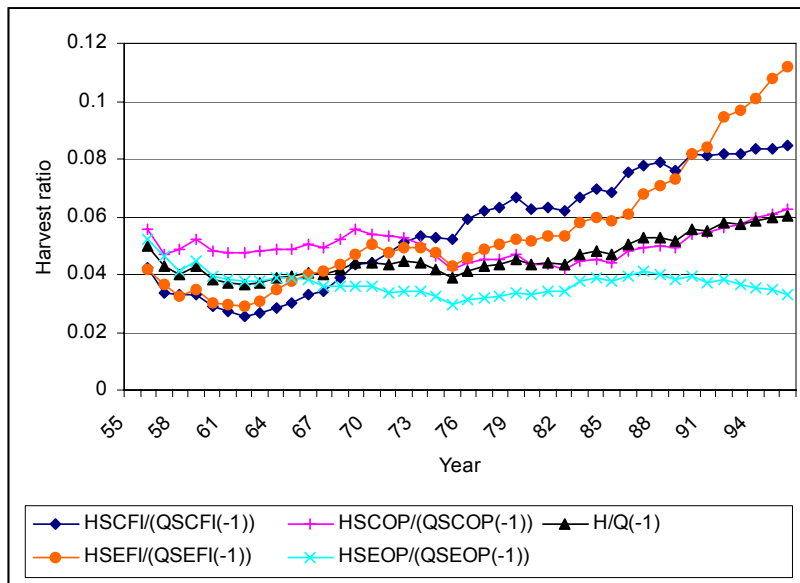


Figure 3 The Time Trends of the Harvest Ratios in U.S. South

Test for stationarity

Typical forms of the nonstationary data process include random walk with drift and trend stationary process (Greene 2002, pp.636-646). Consider an AR(1) process: $Z_t = u + \beta t + \rho Z_{t-1} + \varepsilon_t$. Where Z is a time series, u , ρ , β are parameters, and ε_t is a white noise disturbance term. By subtracting Z_{t-1} from the above equation, we obtain $\Delta Z_t = u + \beta t + (\rho-1)Z_{t-1} + \varepsilon_t$. If $\beta=0$, and $-1 < \rho < 1$, Z is a stationary series. If $\beta=0$ and $\rho=1$, then $\Delta Z_t = u + \varepsilon_t$ and by the definition of integrated process, Z is integrated of order one, denoted as $I(1)$.

Unit root tests are methods for testing cointegration. The Augmented Dickey-Fuller test is one of these methods (Greene, 2002). The regression model for such a test is

$$\Delta Z_t = u + \beta t + (\rho-1)Z_{t-1} + \sum_{j=1}^p \gamma_j \Delta Z_{t-j} + \varepsilon_t$$

where p is the number of lags that are included. This method can test the random walk effect while possible time trend exists (McCallum, 1993). This test is equivalent to one tail t-test with the null hypothesis $H_0: \rho=1$ against $H_1: \rho < 1$. The test statistic is the t statistic

$ADF = \frac{\hat{\rho} - 1}{\text{Est.Std.Err}(\hat{\rho} - 1)}$, Dickey and Fuller (1979) showed that the distribution of the statistic

under the null hypothesis is nonstandard. MacKinnon (1991) produced the critical values for unit root tests, permitting the calculation of Dickey-Fuller critical values. If H_0 is rejected, we can assume that the series is stationary. Different rounds of the differencing should be applied to eliminate the nonstationary process. By differencing repeatedly, most of the nonstationary series will end up as stationary.

Augmented Dickey-Fuller test for HSCFI/QSCFI(-1) has an ADF = -0.083267 (with no time trend, but with 1 lagged difference). The 5% Dickey-Fuller critical value for this test is -

2.9378. The null hypothesis of $\rho = 1$ cannot be rejected. Level series is nonstationary. The Unit Root Test for the 1st difference of the same variable has an ADF= -4.158142 and the 5% critical value is -2.9399. The null hypothesis is rejected. So HSCFI/QSCFI(-1) is $I(1)$. Augmented Dickey-Fuller tests for HSEFI/QSEFI(-1), HSCOP/QSCOP(-1), HSEOP/QSEOP(-1), HSEFI/QSEFI(-1), H/Q(-1), HSCFI, HSCOP, HSEFI, HSEOP, planting, timber price, and interest rate have the similar results. They are all $I(1)$ at 5% critical value.

Because these important data series for timber models are all $I(1)$, the first difference of these series provides the stationary variables for proper model estimation.

The consequences of using nonstationary data

The standard significance tests in regressions involving levels of integrated data are misleading (Greene, 2002). We would like to check how misleading such timber models would be.

On the following page are the estimated results of four specifications for the two ownerships in the two sub-regions. Numbers in parentheses are P-values for the t tests of the estimated coefficients above them. D(·) is a symbol for transforming a series into its first difference.

With our data, OLS regressions for harvest ratios on stumpage prices and interest rates have results that are far different from the results with first differences. As expected, the OLS estimators with levels of these series have resulted in more significant estimated coefficients than those with first differences. In the results, those with level data (equations in odd numbers) are theoretically invalid. Some of the estimated coefficient, like those in model 3, 7 and 19, are more than 1. These regressions have violated the $\rho < 1$ assumption of autoregressive models. In some special cases the autoregressive regression of a model based on $I(0)$ may have estimated coefficients and DW statistics very close to those from the regressions based on $I(0)$ data. But these are only coincidences. They only happen when the data are $I(1)$ and the coefficient of AR(1) is close to 1. This is because the Cochrane-Orcutt method happens to difference the series. This coincidence can explain why Adams (1986) found that differencing data can replace AR(1) specification. We also have such a coincidence for the 19th regression above. But further valid specification correction for the 19th model is not available. We cannot rely on such coincidences.

SCFI(Southcentral Forest Industry)

1	HSCFI/QSCFI(-1) = -0.0004218 + 0.05990*P + 0.216792*R	
	P-value (0.97) (0.00) (0.00)	DW = 0.24
2	D(HSCFI/QSCFI(-1)) = 0.0010 + 0.00788*D(P) - 0.0147*D(R)	
	P-value (0.02) (0.04) (0.31)	DW = 1.37
3	HSCFI/QSCFI(-1) = -0.0500 + 0.00774*P - 0.01515*R + [AR(1)=1.01]	
	P-value (0.82) (0.04) (0.30) (0.00)	DW = 1.40
4	D(HSCFI/QSCFI(-1)) = 0.0012 + 0.00882*D(P) - 0.00763*D(R) + [AR(1)=0.204]	
	P-value (0.01) (0.01) (0.54) (0.16)	DW = 2.11

SEFI(Southeast Forest Industry)

5	HSEFI/QSEFI(-1)	= -0.0164355 + 0.0771272*P + 0.267409*R		
	P-value	(0.20) (0.00) (0.00)		DW = 0.33
6	D(HSEFI/QSEFI(-1))	= 0.0016328 + 0.0103538*D(P) + 0.0052389*D(R)		
	P-value	(0.00) (0.02) (0.75)		DW = 1.41
7	HSEFI/QSEFI(-1)	= 0.02585 + 0.0087103*P + 0.00068*R + [AR(1)=1.07]		
	P-value	(0.00) (0.02) (0.96) (0.00)		DW = 2.02
8	D(HSEFI/QSEFI(-1))	= 0.00189 + 0.00858*D(P) + 0.0071*D(R)+[AR(1)=0.26]		
	P-value	(0.01) (0.03) (0.64) (0.10)		DW = 2.27

SCOP(Southcentral Other Private)

9	HSCOP/QSCOP(-1)	= 0.0392574 + 0.0121353*P + 0.0182491*R		
	P-value	(0.00) (0.01) (0.28)		DW = 0.23
10	D(HSCOP/QSCOP(-1))	= 9.198e-05 + 0.00905*D(P) - 0.00046*D(R)		
	P-value	(0.80) (0.01) (0.97)		DW = 1.57
11	HSCOP/QSCOP(-1)	= 0.04210 + 0.01001*P + 0.002932*R + [AR(1)=0.91]		
	P-value	(0.00) (0.00) (0.81) (0.00)		DW = 1.46
12	D(HSCOP/QSCOP(-1))	= 0.00030 + 0.00825*D(P)+0.00077*D(R)+[AR(1)=0.03]		
	P-value	(0.35) (0.00) (0.94) (0.82)		DW = 1.72

SEOP(Southeast Other Private)

13	HSEOP/QSEOP(-1)	= 0.0459573 - 0.01071869*P - 0.0037529*R		
	P-value	(0.00) (0.00) (0.77)		DW = 0.62
14	D(HSEOP/QSEOP(-1))	= -0.00049 + 0.00355*D(P) - 0.0035500*D(R)		
	P-value	(0.12) (0.20) (0.74)		DW = 1.82
15	HSEOP/QSEOP(-1)	= 0.03335 + 0.00219*P - 0.00142*R + [AR(1)=0.75]		
	P-value	(0.00) (0.38) (0.88) (0.00)		DW = 2.00
16	D(HSEOP/QSEOP(-1))	= -0.00036+0.00301*D(P)-0.00295*D(R)+[AR(1)=-0.004]		
	P-value	(0.22) (0.25) (0.76) (0.97)		DW = 2.21

The whole South

17	H/Q(-1)	= 0.02722 + 0.01986*P + 0.07400*R		
	P-value	(0.00) (0.00) (0.00)		DW = 0.30
18	D(H/Q(-1))	= 0.0002 + 0.00682*D(P) - 0.00353*D(R)		
	P-value	(0.51) (0.02) (0.73)		DW = 1.63
19	H/Q(-1)	= 29.624 + 0.00682*P - 0.00353*R + [AR(1)=1.00]		
	P-value	(0.99) (0.01) (0.74) (0.00)		DW = 1.63
20	D(H/Q(-1))	= 0.00038 + 0.00624*D(P) - 0.00228*D(R) + [AR(1)=0.035]		
	P-value	(0.18) (0.01) (0.80) (0.80)		DW = 2.26

Pooled model with panel data is another option. Would pooling the data series help eliminate the non-stationarity problem for our simple example? The models for pooled level data and differenced data can be

$$\text{Model (1)} \quad [H/Q(-1)]_{it} = \alpha_1 D1 + \alpha_2 D2 + \alpha_3 D3 + \alpha_4 D4 + \beta_1 P_t + \beta_2 R_t + \varepsilon_{it} \text{ or}$$

$$\text{Model (2)} \quad [D(H/Q(-1))]_{it} = \alpha_1 D1 + \alpha_2 D2 + \alpha_3 D3 + \alpha_4 D4 + \beta_1 [D(P)]_t + \beta_2 [D(R)]_t + u_{it}$$

Where model (1) is a level data model while model (2) is a differenced data model. $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ are parameters and D1, D2, D3, D4 are dummy variables for Southcentral Forest Industry (SCFI), Southeast Forest Industry (SEFI), Southcentral Other Private (SCOP), and Southeast Other Private (SEOP) separately. u and ε are the disturbance terms. $i = \text{SCFI, SEFI, SCOP or SEOP}$. t denotes time. $D(H/Q(-1))_{it}$ has to be calculated separately for each i to avoid mistake in transformation. The result of pooled panel data regressions is shown in Table 1.

Table 1 Estimated Coefficients of pooled data regressions for Nonstationary (model (1)) and Stationary data (model(2))

	Model (1)	Model (2)
β_1	0.00346 ** (0.00)	0.0077** (0.00)
β_2	0.124** (0.00)	0.0034 (0.61)

Note: numbers in parentheses are the p-values for t-tests

** : significant at 0.01 level .

Again the regressions with level data result in more significant estimated coefficients, which are misleading, than those with first differences. Furthermore the estimated coefficients of the level data model are much larger. The effects of the variables in these models have been overestimated by the level data regression.

The above discussion attempts only to show the existence and the consequences of the non-stationarity problem. It is not meant to be a complete solution for the problem. [Although differencing helps eliminate the nonstationarity it can correct only some of the data problem or specification errors that may exist.](#) It should be noted that new problems may arise as a result of differencing, which would require other techniques to address such problems.

CONCLUSION

Many time series of the southern US timber market are nonstationary. Models based on levels of these series are misleading, and sometimes the estimated coefficients are quite different from those of models with stationary series. The data series of timber models for the southern timber market have to be checked and transformed for stationarity to make the resulting models for the South econometrically correct.

FUTURE RESEARCH

The simplest way to correct models with integrated variables is differencing series. Recently, however, better ways of solving the nonstationary problem like cointegration have

been developed. We intend to take advantages of this development in econometrics. Already, one such model has recently been reported in Europe (Nyrud, 2002). Developing cointegration models for the South by taking advantage of such development promises to generate much new insights about the southern timber market.

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How Low Can We Go? : Southwide Projections with Low Demand

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Abstract: In the last few years pulpwood and sawtimber markets have exhibited dramatic price decreases and significant mill closures. Many industry analysts are concerned that these changes are not part of a normal business cycle downturn, but instead represent a structural shift in markets as global competition increases. This paper examines the potential consequences of lower demand on the south by using the Southern Forest Assessment models with integrated land use projections, and the beta version of a multi-product model developed by the Southern Forest Resource Assessment Consortium (SOFAC). The price consequences of lower demand are significant and affect the interaction with marginal agricultural land in the rural South. Potential differences by species and product are also examined.

The Global Forest Products Model (GFPM): Structure, Estimation, Applications

Joseph Buongiorno¹, Shushuai Zhu, Dali Zhang, James Turner, and David Tomberlin,

Abstract: The Global Forest Products Model (GFPM) is a dynamic economic equilibrium model of the world forest sector. It predicts the production, consumption, imports, exports, and prices, of 14 product groups in 180 countries. The model describes how world forests and their industries interact through international trade. This paper highlights the methods, data, and computer software of the model. Two selected applications show the usefulness of the GFPM in addressing international economic and environmental issues in forestry.

Key Words: World modeling, forest sector, international trade, supply and demand, prices.

INTRODUCTION

The Global Forest Products Model (GFPM) simulates how the forest sector operates in different countries, and how the countries interact through international trade. The forest sector includes timber production and harvesting, manufacturing in various industries, and transportation of products from forest to industries and to markets.

The purpose of the GFPM model is to predict how, by how much, and when production, consumption, imports, exports, and prices of forest products may change, depending on external or internal forces and policies such as economic growth, global trade liberalization, and new environmental policies governing either the use of forest products, or the management of forests.

For the past forty years, the demand for forest products has grown steadily, and the related international trade has expanded even faster. The GFPM is aimed at clarifying the causal mechanism and magnitude of the relation between general economic growth, the forest sector of individual countries, and the corresponding exchanges between countries. Changes in the forest sector have been profound, and rigorous quantitative analysis is needed to better understand the linkage between macro-economic shocks and the global forest sector response.

In terms of trade policies, the most recent important treaty is the 1994 Uruguay Round of the General Agreement on Tariffs and Trade (GATT). Despite the Uruguay Round agreement, tariffs remain a significant barrier to trade for forest products. To help the US trade representative office evaluate new initiatives we analyzed the possible effects of accelerating tariff liberalization (Zhu et al. 2001). That exercise revealed shortcomings in the GFPM methodology, such as implicit transportation costs, and lack of welfare analysis, that were addressed in the model version presented here.

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In a global economic context, few major issues pertaining to the forest sector can be analyzed in isolation. Exogenous economic shocks like the Asian economic crisis may have a major impact on the well being of industries in countries outside of Asia. International agreements abolishing tariffs could change the relative competitiveness of countries in ways that are not yet known. The push for increased paper recycling in large regions, such as the United States or the European Union may lead to unforeseen advantages for these regions' pulp and paper industries, to the detriment of foreign paper producers, causing foreign retaliation. The applications of the GFPM show how national objectives can be placed in a global context to facilitate better-informed policies.

History of the GFPM

The model structure used in the GFPM can be traced back to the development of the PAPYRUS model of the United States pulp and paper industry (Buongiorno and Gilless 1983, Gilless and Buongiorno 1987). The PAPYRUS model was developed for the USDA Forest Service to assist in the Timber Assessments required by the Resources Planning Act, in conjunction with the Timber Assessment Market Model (TAMM) of the solid wood sector (Adams and Haynes 1980).

The PAPYRUS was built with a general model structure and related software, the Price Endogenous Linear Programming System (PELPS), meant to model any economic sector with spatial and dynamic elements. The first international application of PELPS was a prototype model (GTM-1) of forest products trade developed at the International Institute of Applied Systems Analysis (IIASA) in the summer of 1983. This prototype was much expanded and improved upon by IIASA researchers into the Global Trade Model (GTM), described in Kallio et al. (1987). A modified version of the GTM model (CGTM) is being maintained at the Center for International Trade in Forest Products (CINTRAFOR), University of Washington, and has been used in many international studies (Perez-Garcia et al. 1999).

Meanwhile, the PAPYRUS model became the North American Pulp and Paper (NAPAP) model, developed and maintained by the USDA Forest Products Laboratory, in collaboration with the University of Wisconsin, and with the Canadian Forest Service (Zhang et al. 1996). A similar model for the North American solid wood sector (NASAW) was also developed at the USDA Forest Products Laboratory. The PELPS software was progressively improved. The latest version, PELPS IV, which forms the structure of the GFPM model, is described in Buongiorno et al. (2003).

PELPS IV is a general microcomputer system for modeling economic sectors. It is based on price endogenous linear programming, a method of combining regional information on supply and costs into spatial sector models. The objective function of the spatial equilibrium problem is called the "net social payoff", that is, the value of the end products to consumers, minus the cost of producing and transporting them. PELPS IV has static and dynamic phases. In the static phase, it computes the quantities and prices that match demand and supply for all commodities in all regions in a given year. In the dynamic phase, it predicts the evolution of this spatial equilibrium from year to year.

The first major international application of the PELPS system was to project trends in demand and supply of tropical timbers in the Asia-Pacific region. This was followed by a global application of the system, leading to the first version of the GFPM model to produce the 1997 FAO provisional outlook for global forest products consumption, production and trade to 2010 (FAO 1997). That report contained the first fully equilibrated (in an economic sense) long-term

projections by country and product of production, consumption, imports, exports and prices. The following year, the definitive projections to 2010 of global forest products consumption, production, trade and prices were projected, with revised exogenous assumptions and an improved GFPM model structure, for the FAO 1999 Global Forest Products Outlook Study. Since, the GFPM has been improved and simplified continuously while being applied to several other studies, two of which are described below.

GFPM Structure

The GFPM integrates the classical four major components of forest sector models (Kallio et al. 1987): timber supply, processing industries, product demand, and trade. Each year equilibrium is computed by maximizing the global “net social payoff” (Samuelson 1952), while year by year changes are simulated by recursive programming (Day 1973). The GFPM is designed mainly as a policy analysis tool, to project the general future trends in quantities and prices at different stages of transformation, under different scenarios. The model shows how production, consumption, imports, exports, prices, and welfare are likely to change in response to changing economic environments (such as changes in economic growth, tariffs, or technology). Because it can predict prices, a critical input in making investment decisions, the model also gives relevant information for private concerns.

The general principle of the GFPM is, then, that global markets optimize the allocation of resources in the short run (within one year). Long run resource allocation is partly governed by market forces, as in capacity expansion and trade, and also by political forces such as the wood supply shifts determined by forest policy, the wastepaper recovery rates influenced by environmental policy, the trade tariffs that change the cost of imports, and the techniques of production determined by exogenous technological progress.

Every year, demand, supply, trade and prices are computed that clear markets for all products in all countries. This is the spatial global equilibrium computed by the static phase of the model. Then, the model parameters are updated to reflect exogenous and endogenous changes from one year to the next. This is the dynamic phase of the model. Exogenous changes are assumptions regarding economic growth, technical change, potential timber supply and trade inertia. Endogenous changes, determined by the model, include capacity growth and availability of recycled fibers. This results in a new demand-supply system. The model then computes the quantity-price equilibrium next year as shaped by the intervening changes. It reiterates the static and dynamic phases for every year until the end of the projection.

The equilibrium for each year of the projection is obtained with an optimization model that simulates world markets. It finds the production, consumption and trade that maximize the total value of consumption minus the total cost of production and transportation, for all products in all countries, in a given year. The shadow prices of the material balance constraints give the market-clearing prices for each commodity and country (Hazell and Norton 1986).

From one year to the next, demand changes in each country due to changes in the gross domestic product (GDP). The wood supply shifts exogenously according to a chosen scenario. The amount of recycled fiber changes with technology and recycling policies. Capacity increases or decreases according to new investments that depend on past global production, and the profitability of production in different countries, as revealed by the shadow price of capacity. Tariff changes affect the price of imports, *ad-valorem*. Then, a new equilibrium is computed, subject to the new demand and supply conditions, new technology, new capacity, and new tariff. Trade changes with inertia tied to past trade and GDP growth.

The goal of welfare analysis is to estimate the change in consumer surplus and producer surplus induced by a change in policy, for example the elimination of import tariffs. Computing this total change in welfare is generally not feasible because the GFPM uses only a segment of the demand and supply curves around the equilibrium point. Instead the GFPM produces estimates of the welfare changes when they can be derived subsequently to the calculations of production, consumption, imports, exports, and prices, for two different scenarios.

GFPM Calibration and Validation

The GFPM deals with 180 individual countries and 14 products. Each country may produce and trade one or all of the products. This level of resolution was chosen to facilitate data verification since most international data are collected at the country level. Calculating projections by country also facilitates review and criticism of the projections since expert knowledge is more available at the country level than at more aggregate regional or global levels. The forest products correspond to the product groups used by the FAO in its statistical work. The primary source of the data to establish the base year, and to estimate some of the parameters when needed, was the Food and Agriculture Organization of the United Nations (FAO).

The demand equations for the end products are based on derived demand theory for raw material inputs. Dynamic demand models then lead to empirical elasticities of demand for each forest product with respect to national income (measured by real GDP) and real product price, in constant US dollars.

In any given year and country, the supply of industrial roundwood is tied to its price by a constant price elasticity. In addition, the timber supply curves shift exogenously over time. These rates of shift are estimates of how much timber production would change without a change in price. They vary by country, and are based on various information regarding past production, forest area and stock, growth rates, extent of plantations and policies of each country.

The GFPM simulates the transformation, in each country, of wood and other raw materials into end products or intermediate products, which are in turn transformed into end products. These successive transformations and the attendant supplies and demands are represented by activity analysis, consisting of the input-output (I-O), and of the manufacturing cost parameters.

For most countries these data are not available. In addition, the production data are often inaccurate. The method to estimate the I-O parameters and improve the production data for the GFPM has two steps. First, estimate consumption and production of final products where data are missing or have obvious errors. Second, estimate input-output coefficients while adjusting the production data to make them coherent with prior knowledge of the techniques of production.

Each production activity represented with input-output coefficients corresponds to a manufacturing cost. This cost was estimated for the base year as the unit value of the output, minus the cost of all inputs. Similar to the demand and supply prices, the output and input prices applied to calculate the manufacturing cost are the corresponding net importer and net exporter prices. For example, if a particular country is a net exporter of the output commodity and a net importer of the raw materials, then the net exporter price and net importer prices are applied to calculate the manufacturing cost for this country. So, the manufacturing costs and material costs almost exactly offset output revenues, and net profits were zero as they should be in a competitive equilibrium. The estimation of other parameters, such as capacity growth, trade inertia, paper recovery and freight costs are described in Buongiorno et al. (2003).

The PELPS framework, which forms the basis of the GFPM model has been applied in many studies and has been evolving for more than two decades. The demand and acceptance of studies based on the PELPS represents by itself a validation of the model. The particular application and extension of the PELPS methodology, the GFPM model described here, emerged in 1996 and has been applied in several studies and by different organizations. These applications of GFPM are also part of the validation process.

Comparison of the base year solution with the actual data gives a partial validation of the model and of its parameters. One of the main purposes of the GFPM is to compare results in different scenarios to assess the likely magnitude of changes in forest sector variables resulting from policy and management decisions, for the world or large regions. Therefore, the reasonable behavior of long run trends for aggregated regions is more important than the yearly fluctuation of an individual country.

The model's reasonableness was tested in part by simulating the global forest sector from 1980 to 1994, conditional on known exogenous changes (GDP growth rates and roundwood supply shift rates) between 1980 and 1994. Then, the model projections for each year were compared with the actual statistics. The model's performance over the historical period was judged by a visual comparison of model prediction and historical results via graphs, and with the Mean Absolute Relative Error for the aggregated regions. The projected trends were generally close to the actual data, at regional and world levels (for example Figure 1). The world consumption and production had MARE's less than 6%. The MARE of world imports and exports was less than 10%, except for industrial roundwood, due to the log trade restrictions not considered in the validation model. The projections were most accurate for Europe and North/Central America. The projections tended to be more accurate for processed commodities than for raw materials. The ability of GFPM to give acceptable predictions of the general trends in production, consumption, trade, and prices over long time periods, combined with the agreement of the model predictions with a-priori expectations in various conditions, suggests that the model could be used to address the questions of this study, but the results must be viewed with strong caveats regarding their precision.

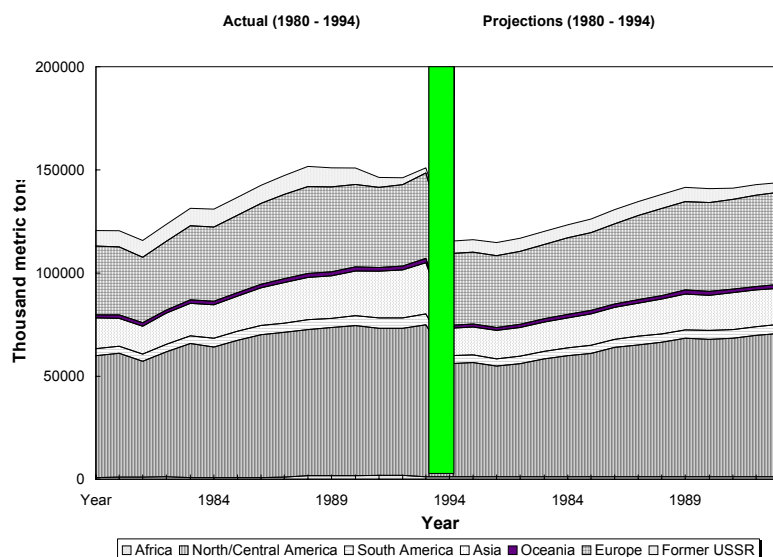


Figure 1 Observed and predicted consumption of wood pulp.

GFPM Applications

One main purpose of the GFPM is to compare results from different scenarios to assess the likely magnitude of changes in forest sector variables resulting from policy, macro economic shocks, or management decisions. A recent base scenario gave detailed projections for all forest products from 1997 to 2010. The purpose of this base scenario was to provide a common base of comparison for other scenarios which considered effects of 1) the Asian economic crisis, 2) tariff liberalization, 3) increased U.S. paper recycling, 4) regional trade agreements on New Zealand, and 5) U.S. timber harvest restrictions.

Base Scenario: The base scenario projections, based on the assumed GDP growth rates, roundwood supply shift rates, and other model parameters, showed that the consumption, production, and trade of forest products would continue increasing over the next decade. World roundwood consumption would increase 25% to 4.2 billion m³ by 2010, and world roundwood trade would increase 70% to 173 million m³. Asia would still be the largest net importer and the Former USSR would remain the largest net exporter. World wood-based panels consumption would increase 54% to 225 million m³ and world trade would increase 29% to 57 million m³. Asia would become the largest net importer and the Former USSR and North/Central America would be the major net exporters (Figure 2). World paper and paperboard consumption would increase 60% to 470 million tonnes in 2010, and world trade would increase 25% to 104 million tonnes. Europe and North/Central America would remain the major net exporters and Asia would double its net imports during the next decade. Because of the strong demand for forest products, world prices would increase. It is unlikely that the price of industrial roundwood or wood-based panels would again reach their 1980 levels. But, prices of sawnwood and papers would recover to near their 1980 levels by 2010 (Figure 3).

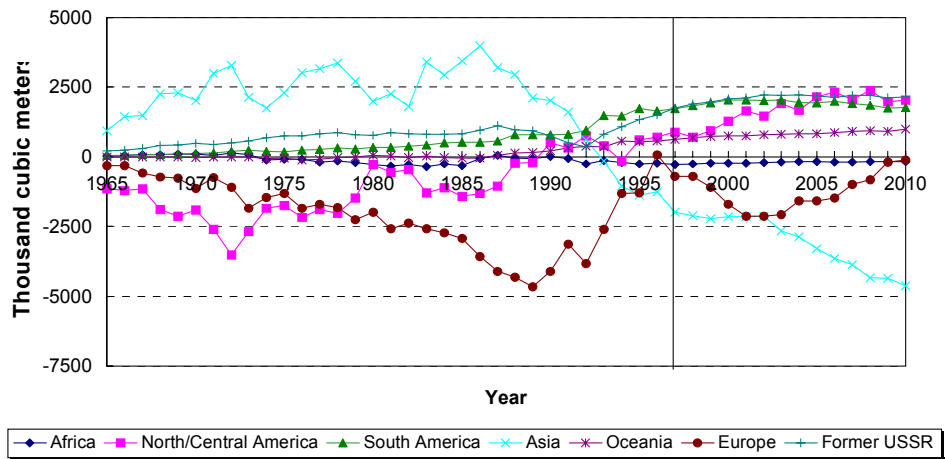


Figure 2 Past and predicted net trade of wood-based panels.

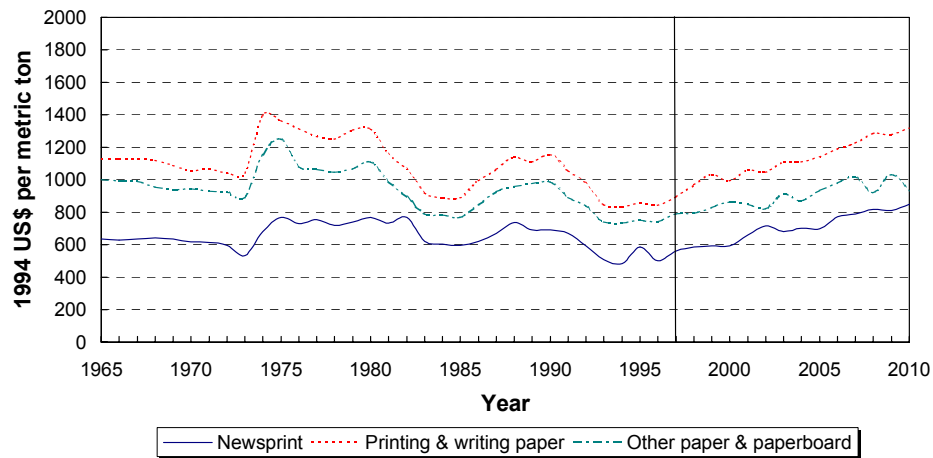


Figure 3 Past and predicted real world prices of paper and paperboard.

In market economies, prices determine in part the demand and supply of forest products. Price levels are also critical in determining the feasibility of forestry and industry projects. It is, therefore, useful that the methodology to predict consumption, production and trade gives also projections of the market clearing prices. But the prices projected by GFPM are better viewed as long-term trends, because the year to year price fluctuations are very sensitive to model parameters and assumptions.

Increased U.S. paper recycling: This GFPM application showed how recycling policies could impact the competitiveness of different countries, and therefore on the global forest products trade, and on the welfare of consumers and producers. These policies, like mandatory minimum recycled fiber content regulations for newsprint, may give, perhaps inadvertently, a cost advantage to United States producers. In this sense, wastepaper-recycling policies may actually serve as a “new” barrier to paper product trade.

An experiment was conducted by projecting production and trade with the GFPM, with and without increased recovery and utilization of waste paper in the United States, other things being held constant. The projections gave detailed results by country and product, on production, imports, exports, and prices, from 1998 to 2010.

The results showed that further paper recycling in the United States would affect the pulp and paper markets in other countries significantly, while it would have little effect on industrial roundwood, sawnwood and wood-based panel production and trade. One main effect would be the reduction of world prices of paper and paperboard. As a result, world demand for paper would increase, attenuating to some extent the substitution of wood pulp by recycled paper.

It was found that the balance of trade of the United States would improve for paper and paperboard, wood pulp, and industrial roundwood. It would only worsen for waste paper. In the rest of the world, the worsening of net trade would occur mostly in Asia. Europe would benefit to some extent from the increase in world demand due to lower prices.

The total welfare of agents in the world forest sector, measured by consumer and producer surplus would change little due to increased paper recycling in the United States. However, the welfare of consumers would increase substantially, while that of producers would decrease. Net welfare gains would occur in major consumer countries such as the United States, Germany and the United Kingdom, while major producers such as Canada, Finland and Sweden would suffer the largest losses (Table 2).

Table 2 Projected average annual welfare differences due to increased paper recycling in the United States from 1998 to 2010.

Region	Consumers	Producers	Total
	10 ⁶ US\$	10 ⁶ US\$	10 ⁶ US\$
Canada	262	-1786	-1523
United States	13510	-9170	4340
Brazil	322	-557	-235
ASIA	2068	-1215	853
China	703	-510	193
Japan	351	-245	106
Korea, Rep.	379	-183	195
Finland	123	-607	-484
France	835	-541	294
Germany	724	-221	504
Italy	623	-165	458
Sweden	114	-737	-623
United Kingdom	809	-258	551
WORLD	21825	-17511	4314

The GFPM results confirm the general belief that wastepaper recovery and recycling are a way to extend forest resources. Furthermore, they suggest that with this scenario there would be hardly any effect on the price of industrial roundwood. Thus, it is unlikely that the forest stock would be reduced due to forest land conversion to other uses, or that forest management and timber supplies would decrease due to the increase in recycling considered here.

CONCLUSION

Many improvements of the GFPM are possible (Buongiorno et al. 2003). Nevertheless, as it stands, the GFPM is already useful for understanding the world forest economy. Forest sector issues have become increasingly complex due to the increase in the goods and services provided by forests and the inter linkages within the forest sector and between the forest sector and others. Forest sector issues have also taken on a global perspective, due to stronger links between nations through globalization, trade liberalization, and international treaties.

Quantitative modeling is necessary to order this complexity, understand its processes, and forecast its changes. The GFPM has enacted this quantification by building on the experience of many preceding models, using rigorous theory, econometric parameters, a large amount of hard data, and a fair amount of expert knowledge (particularly on the timber supply side). As a result, the GFPM is one of the few truly international forest sector models, providing a full description of forest production, wood manufacturing, and end product demand, with detailed coverage of individual countries and commodity groups.

The GFPM can be used in many different ways. For some users it can be a forecasting tool, to project future production, consumption, trade, and prices based on a particular economic growth scenario. For others it can be a powerful means of policy analysis, for various trade and environmental issues. For analysts and researchers, it can be a way to understand better the interactions between parts of the forest sector, especially between markets and forests, in an international context. Although the data deal with the forest sector, the method is general enough that the model structure can be applied to agricultural or industrial sectors as well.

More applications of the GFPM and details on methods and data can be found in Buongiorno et al. (2003). The data and the GFPM software are available at: www.forest.wisc.edu/facstaff/buongiorno/book/index.htm.

ACKNOWLEDGMENTS

The research described in this paper was supported in parts by the USDA Forest Service, Pacific Northwest Station and Forest Products Laboratory, the USDA-CREES-NRI grant 98-3500-6110, by Mc Intire-Stennis grant WIS04456, by the Food and Agriculture Organization of the United Nations, and by the School of Natural Resources, University of Wisconsin, Madison.

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The Influence of Regulatory Forest Policy Tools on the Biodiversity of Woody Vegetation in Ukraine

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Abstract: Making the transition from a state oriented forest economy to a market oriented one is very difficult without critical analysis of the set of tools designed to implement state forest policies. One of the important goals of Ukrainian forest policy is conservation of the biodiversity of forest ecosystems. This paper analyses the influence of two of the regulatory forest policy instruments (zoning and prohibition of final harvesting) on the biodiversity of woody vegetation. Data on the forest resources of the Sumy administrative oblast in Ukraine are used in the analysis. Additionally, we look at how biodiversity of woody vegetation is affected by the form of forest tenure.

INTRODUCTION

Since its independence in 1991, Ukraine initiated reforms to build a democratic political system and free market economy. Being a member of the Pan-European Forestry Process, Ukraine is committed to the principles of sustainable forest management (MAFF, 1993; MARDF, 1998).

According to Solberg and Rykowski (2000), “A long range of studies is found of various forest policy instruments, but near all of the studies are only describing the instruments... Statistical testing of the hypothesis about the impacts of the forest policy instruments hardly exists.”

We will start by outlining legal and institutional frameworks, as well as goals of Ukrainian forest policy and means of its implementation.

During the last decade significant changes took place in Ukrainian legislation, first of all in property relations, and in particular, property relations concerning land and other natural resources. These changes occurred in several iterations, as it is impossible to transform from socialist to a market economic system all at once, and the system is still in development.

The Land Code (2001.10.25 № 2768-III) defines the main concepts of land relations, forms of ownership, powers of state authorities to regulate land relations, restrictions and conditions of land transactions, changes of land use, etc. According to Article 56, lands of the forest fund (lands, which are designated for the purpose of forestry) could be in state, communal, or private ownership. Parcels of the forest fund, owned by the State can be granted for permanent use to state or communal specialized forestry enterprises, or leased by private specialized forestry enterprises. Small (up to 5 hectares) parcels of forest can be acquired by farmers and persons having special training. Furthermore. The Land Code now allows privatization of parcels of marginal agricultural lands for the purpose of afforestation.

Forest relations in Ukraine are regulated by the Forest Code (1994.01.21 № 3852–12). Supreme Rada (Parliament) has the right of disposal (to grant for permanent use or lease) concerning state owned forests as well as legislative regulation of forest relations and definition of state forest policy. It can delegate the right of disposal to the legislatures of provinces or the district level. The Cabinet of Ministers is charged with supervising the protection, use and

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reproduction of forest resources. Particular responsibilities are delegated to the Ministry of Environmental protection and to the State Committee of Forestry.

So far practically all forests belong to the State. According to the State Forest Cadastre (MFU, 1997) in 1996 the two largest groups of forest holders were state forestry enterprises (SFEs) reporting to the Ministry of Forestry (now — State Committee of Forestry), which managed 66 percent of forests, and collective agricultural enterprises (cooperatives) (CAEs), managing 24 percent of forests. Remaining parts of the forest were granted for permanent use to the enterprises reporting to different government agencies. Only a tiny part amounting to 6.8 thousand hectares or 0.06 percent of the forest fund were in permanent use of private persons.

The main principles of forest policy are outlined in the Forest Code (1994). It states that “Ukrainian forests are national assets and they fulfill mainly environmental, aesthetical, pedagogical and other functions, have limited exploitational value and are subject to state accounting and protection.” A more detailed list of the goals of Ukrainian forest policy can be found in the State Program “Ukrainian Forests” (2002.04.29 № 581):

- increase of forest cover to the optimal levels by (natural) zones;
- increase of productivity and enhancement of composition of forests lands;
- raising of environment protection potential of the forests, maintaining their biodiversity;
- increase of resistance of forest ecosystems to the influence of negative environmental factors and climate changes;
- expansion of the use of methods of rational utilization of forest resources;
- expansion of work on protective afforestation and forest amelioration;
- perfection of normative-legal base of forest management and its harmonization with international principles of sustainable forest management;
- increase of state monitoring of the protection, use and reproduction of forests;
- development of forest science and education;
- increase of social protection of the forestry workers.

In implementing its forest policy, Ukraine relies mostly on mandatory (regulatory, administrative) and partly complementary (mainly education) tools, almost completely ignoring voluntary (financial-economic and market) tools (classification of forest policy tools according to Merlo and Pavari, 1997). This situation is not surprising for an economy in transition. The main regulatory policy tools control harvests in order to achieve a continuous wood supply and provide environmental benefits by zoning, protecting forests in certain areas, and specifying rotation ages, minimal stocking levels, and allowable cuts.

The goal of our current research is to attempt to analyze how certain aspects of the institutional infrastructure of forest management, namely, protection regimes and the tenure system, influence biodiversity of woody vegetation.

The elements of regulatory forest policy instruments being studied are the system of groups of forests, and categories of exclusion from final fellings. These instruments are implementations of state forest policy directed towards maintaining the environmental and social functions of forests. All forests of Ukraine are divided into two groups depending on the primary goal of forest management. Forest groups are assigned to large contiguous tracts of forest, similar to zoning. Forests of the first group are managed primarily for water and soil conservation, recreation, protection of roads and railways, etc. Limited harvesting under strict regulations is allowed in approximately half of the forests of the first group. If harvesting is allowed, rotation ages are longer than in forests of second group, based on the assumption that older stands generally provide more non-timber values. The forests of the second group are

managed for both wood and environmental values. In addition, certain stands in both first and second groups of forests could be designated as “specially protected areas” and excluded from commercial use. Examples of such specially protected areas are forest edges, forests near sources of rivers and streams, key habitats, etc.

Table 1. Distribution of forests by groups and possibility of exploitation in Ukraine

Group	Forested land				Of which possible for final harvesting			
	Area, thousand ha		Volume, million m3		Area, thousand ha		Volume, million m3	
First	5132	55%	877	51%	1854	20%	356	21%
Second	4268	45%	859	49%	3826	41%	753	43%
Total	9400	100%	1736	100%	5680	60%	1110	64%

The second element of institutional infrastructure being studied is forest tenure. Despite the fact that all forests are the property of the State, forest holders have different bundles of property rights concerning forest resources, which makes it possible to distinguish tenure systems and analyze their economic and ecological consequences. The most significant difference between the two largest groups of forest holders, SFEs and CAEs, is the fact that state forestry enterprises are simultaneously forest holders conducting forest management, and authorities, authorized by the State to supervise forest management in all the forest within the region of responsibility. This combination of management and supervision could have several consequences. First of all, we have a conflict of interests, which could result in inappropriate supervision over the management of “own” forests. On the other hand, being busy with forest management, the forest service could spend too little time supervising forest management and enforcing regulations in “other” forests. The other differences between state forestry enterprises and CAEs are size, availability of professionals, corporate culture, sources of financing, etc. These factors could suggest “better” management in the forests of state forestry enterprises.

METHOD

There are a number of indices for the estimation of biodiversity. Each of them is a very simplified way to describe such a complex entity as an ecosystem. For the characterization of species biodiversity we used Shannon's index (Shannon and Weaver, 1963; Odum, 1971), calculated by the formula:

$$H' = - \left(\sum_{i=1}^n p_i \ln p_i \right),$$

where

H' – Shannon's index;

p_i – proportion of the individuals of each of the species of the system.

The distinctive feature of Shannon's index is that it allows us to characterize simultaneously the number of species and the variation of shares of individual species in an ecosystem. The value of the index increases with increasing numbers of species, achieving a maximum value when shares of individual species are distributed evenly.

The analysis of the influence of forest management on biodiversity has been performed using OLS. Explanatory variables of interest for the research are the ones characterizing the

system of forest management, in particular, the tenure system, the “group of forests”, and possibility of exploitation. It is reasonable to assume that a more strict protection regime (if forest belong to the first group and/or it is excluded from exploitation) would increase biodiversity levels. We have no opinion about how land tenure influences biodiversity. In addition, the variables describing natural site conditions were included into the regression equation. The level of biodiversity is influenced by site conditions, stand origin, group of species, age, stocking, and geographical location. A higher level of biodiversity is expected in richer site conditions. It is reasonable to assume that with age it first decreases, and then (in mature and overmature stands) could slightly increase. A similar relationship could hold with stocking – higher levels of biodiversity may be found in stands with low and high stocking. Higher levels of biodiversity are expected in natural stands, as well in the stands dominated by broadleaved species. The conceptual model as follows:

$$H' = f(T, G, E, O, S, U, A, P, R),$$

where

- H' – Shannon's biodiversity index;
- T – form of tenure;
- G – group of forests;
- E – possibility of exploitation;
- O – origin (natural or planted);
- S – group of species;
- U – type of site conditions;
- A – age;
- P – stocking;
- R – administrative district.

DATA

The data used is a subset of the database “Forest Fund of Ukraine” covering SFEs and CAEs of Sumy oblast dated 1996. The data set used contains records with descriptions of 139299 forest stands, of which 53642 represent forests managed by CAEs.

The biodiversity index (H') was calculated using descriptions of the first and second canopies, understory regeneration, and single trees (each of these elements are considered as separate “canopies” of the stands). Most of studies use the number of individuals of each of the species to calculate share of each species composing the ecosystem. Because these data are not available, we used the coefficient of composition as proxies. For the stands consisting of several “canopies” the shares of species were weighted using stocking of each “canopy”. The biodiversity index in the current data set takes real numbers in a range from 0 (for the stands with single species) to 2.035.

Other variables taking real values are stocking or dominant canopy and age. Because of age as an index reflecting stand stage of development is not comparable for the stands with different dominant species, age was normalized by dividing by the rotation age. In addition, because biodiversity could be nonlinearly related to the stage of stands’ development and stocking, squared age and stocking were entered to the equation.

All other variables are categorical, that is, they are measured with nominal or ordinary scales. For these variables dummy variables were created. The form of tenure (T) takes the value of 0 for the forests managed by state forestry enterprises and 1 for the forests managed by

agricultural enterprises. The forest group (G) takes value 1 for forests of the first group and 0 for the rest (forests of the second group). Possibility of exploitation (E) = 1 for stands where exploitation is possible and 0 for those excluded from final fellings.

Stands' origin (O) = for artificially regenerated and 0 for the natural stands. Group of species (S) = 1 for coniferous and 0 for deciduous.

Site condition in Ukrainian forest typology is characterized by one of 28 types. Each type of site condition is a combination of trophotop, or richness of the soil, denoted by letters A to D, and hygrotop, or amount of moisture in the soil, denoted by digits 0 to 6. For the representation of trophotop, 3 dummy variables were created, TB, TC, TD, they take value of 1 for the trophotops B, C and D respectively, and 0 in other cases ("base" trophotop is A). For the representation of hygrotop two dummy variables were created: H234 and H56. H234 takes a value of 1 for the hygrotops 2, 3 and 4; H56 takes value of 1 for hygrotops 5 and 6 ("base" hygrotops are 0 and 1). The grouping of hygrotops was done because of absence of enough observations for certain hygrotops, and because of coefficients for hygrotops 2, 3, 4 were not statistically significantly different.

The variable "administrative district" (R) was introduced to recognize influence of natural zones, microclimate, proximity of urbanized areas, and other factors which are difficult to take into account directly. Here were created 18 dummy variables (by number of districts minus 1) $R206$ — $R401$.

Thus, the regression equation has the following form:

$$\begin{aligned} H'_i = & \alpha_0 + \alpha_1 T_i + \alpha_2 G_i + \alpha_3 E_i + \alpha_4 O_i + \alpha_5 S_i \\ & + \alpha_6 TB_i + \alpha_7 TC_i + \alpha_8 TD_i + \alpha_9 H234_i + \alpha_{10} H56_i \\ & + \alpha_{11} A_i + \alpha_{12} A^2_i + \alpha_{13} P_i + \alpha_{14} P^2_i \\ & + \alpha_{15} R206_i + \dots + \alpha_{32} R401_i + \varepsilon_i \quad . \end{aligned}$$

RESULTS

Regression analysis was performed using S-plus 5.0. Stand area was used as a weighting variable. Results of the regression analysis are presented in Table 2.

Table 2. Results of regression analysis of woody vegetation biodiversity (Sumy oblast, 1996)[‡]

Coefficient	Value	Standard error	t-coefficient	P(> t)
Intercept	1.1070	0.0538	20.5673	0.0000
T	-0.1182	0.0026	-44.9095	0.0000
G	-0.0544	0.0026	-20.7024	0.0000
E	-0.0212	0.0025	-8.3756	0.0000
O	-0.2089	0.0026	-81.1407	0.0000
S	-0.2292	0.0035	-65.2307	0.0000
TB	0.0783	0.0077	10.1678	0.0000
TC	0.2242	0.0079	28.3194	0.0000
TD	0.3980	0.0084	47.4813	0.0000
H234	-0.2934	0.0477	-6.1455	0.0000
H56	-0.7507	0.0479	-15.6698	0.0000
A	-0.3768	0.0058	-64.4691	0.0000
A ²	0.0550	0.0021	26.1230	0.0000
P	-0.3502	0.0759	-4.6114	0.0000
P ²	0.3797	0.0554	6.8507	0.0000

[‡] District dummies are not shown

Standard error of the residuals is 0.65 for 139284 degrees of freedom. The multiple $R^2 = 0.39$, so that the regression allows us to explain 39% of the dependent variable variation, which is quite high for this kind of study, and taking into account that the goal of the research is determination of existence of influence of the forest management system on forest biodiversity, rather than use for the prediction.

Form of tenure (T). The coefficient is statistically significant at the >99.99% level. This means that the biodiversity index of the stand in forests managed by CAEs *ceteris paribus* is 0.11 less than that of stands in forests managed by the SFEs.

Forest group (G) and possibility of exploitation (E). Coefficients of both variables are statistically significant at >99.99% level. As expected, biodiversity index is *ceteris paribus* lower for the stands where final fellings are allowed, but, contrary to expectations, it is lower in the forests of first group. This does not contradict each other, as could seem, because of stands excluded from final fellings are both in the forests of first group and in the forests of second group.

Stand origin (O) and group of species (S). Both coefficients are statistically significant on the >99.99% level. As was expected, biodiversity index is lower in artificial forest stands as well as in coniferous stands. The absolute values of the coefficients show differences approximately corresponding to the difference between a pure pine stand and a pine stand with 3% of birch and 3% of oak.

Coefficients of regression of the variables characterizing type of site conditions (TB, TC, TD, H234 and H56) are statistically significant at >99% level. Biodiversity increases with soil fertility and decreases with soil moisture.

Coefficients of the dummy variables (*R206—R401*) are statistically significant at the 99% level except three. But the statistical significance of categorical variables having more than 2 categories can not be judged on the basis of the statistical significance of separate dummy variables because they make sense only if they enter the equation together. That's why for the regression coefficients characterizing administrative district, a joint *F*-test was conducted. $F_{(18, 139284)} = 223.1$, which is significant at 99% level. Thus, variables *R206—R401* belong to the regression and are statistically significant.

CONCLUSIONS

Maintaining and enhancing biodiversity has emerged as a universal goal of sustainable forest management. As we mentioned above in our reference to the Solberg and Rykowski (2000) report, little statistical testing of impacts of forest policy instruments has been conducted to date. With this study, we have offered an analysis of the medium-term (50 years) effects of tenure arrangements and zoning assignments on a measure of biodiversity for forests in a region of Ukraine. In its broadest sense, biodiversity incorporates both fauna and flora. In our study, we have restricted our analysis to woody vegetation, a reasonable simplification for analysts of forestry institutions and policies.

Tenure arrangements were examined to determine their relationship to biodiversity levels. The current tenure situation in Ukraine has been in place for over half a century, adequate time to observe differences in the effects of management employed by the two major groups of forest holders. Forests managed by SFEs were associated with higher biodiversity levels than forests managed by CAEs, controlling for other factors. This could possibly be explained in two ways. First, state forestry enterprises have more educated staff, better access to financial resources, and a forestry-focused corporate culture that provides them with better opportunities for achieving their management objectives. Second, since the state forestry enterprises are charged with managing lands under their control and monitoring activities on all forest lands, including those managed by collective agricultural enterprises, they may be ineffectively monitoring the CAE lands.

Our analysis results indicate that controlling the degree of exploitation of certain forests effectively yields higher levels of biodiversity. However, results of our analysis yield the opposite result for the designation of "forest groups". Forests of the "First group" are associated with lower biodiversity levels, other things being equal. Lower biodiversity levels in forests of the "First group" could serve as evidence that the difference between management regimes of forest groups is not sufficient to realize declared goals. Another explanation of this finding could be the higher anthropogenic pressure in those forests of the "First group" which are managed for recreation. Further analysis of this consideration could separate forests of the "First group" into more detailed categories (recreation forests, protection forests and so on) which might aid in understanding differences in biodiversity levels.

ACKNOWLEDGEMENTS

Authors appreciate valuable comments and help of the following colleagues: Roger Brown, Joseph Buongiorno, John D. Jackson, David N. Laband, Viktor A. Lesnyk, Oleksandr V. Polyakov, Greg L. Somers, Anatoliy D. Zaremsky.

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Interest Groups and the Softwood-Lumber Dispute

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INTRODUCTION

Canada and the United States, neighbors and longtime trading partners, continue in one of the world's largest trade disputes: the battle over softwood lumber. Traditionally, understanding of the dispute relies on economic analysis and trade policy research. Interest group theory provides another framework for generating useful insights into the ongoing situation. By using a form of interest group taxonomy to categorize the participating interest groups and associations, we find difficult tradeoffs and unexpected coalitions occurring throughout the lumber dispute as groups attempt to meet the needs of their members while influencing trade policy.

The softwood lumber dispute between Canada and the U.S. shows the participating interest groups falling into four distinct categories: single-issue, multi-issue, business and government. Single-issue groups focus on the policy goals specific to the ongoing lumber dispute. Multi-issue groups have multiple goals and engage in the lumber dispute as part of advancing a broader agenda of objectives. Business groups rely on the aims and objectives of individual business members, using policy negotiations as business tools. Government actors pursue objectives that combine the goals of the interest and business groups within their country.

What can interest group taxonomy tell us? The objectives of groups participating in the U.S. Canadian lumber dispute exceeded the narrow issue of tariffs. While single-issue groups followed the purist goal of influencing policy outcomes, most groups balanced multiple goals. Thus, depending on their primary goals, groups placed varying importance on influencing the public policy of Canadian softwood lumber.

When assessing group effectiveness in influencing lumber policy, the taxonomy categorizes participants along logical lines. Single-issue groups demonstrate marked focus and success in communicating and implementing efforts to affect policy change. Multi-issue groups offered proposals and support for the lumber dispute; the needs of their members did not require total dedication to a single issue. Businesses and trade associations took a pragmatic approach, balancing operational needs and financial performance with the potential policy changes. Government officials and agencies acted, primarily, as arbiters, helping to shape and implement policy compromises.

Categorizing participants for disparate policy disputes can help us understand policy creation. Interest group theory helps us see how policies change and why, providing insight into who may be the winners and losers and why. This helps us as researchers, and as active citizens seeking to effectively influence policy outcomes.

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Assessment the Profitability of Intensive Silvicultural Treatments in the U.S. Pulp and Paper Industry

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Abstract: Current economic analysis shows that fiber costs represent up to 40% of the total cost to manufacture paper in the U.S. The U.S. paper industry must compete with emerging forest countries, located near the equator, whose costs are significantly lower. The U.S. could offset these cost disadvantages by incorporating biological technologies and more intensive management regimes, which would lead to improved tree growth, as well as better wood and fiber qualities. In turn, this would maximize processing efficiency, product performance, and give a better economic return.

The forest cost model considers both mill (fiber production) and NIPF (timber production) perspectives. The optimum rotation age is evaluated using bare land value criterion (BLV) in thinned and unthinned management regimes. This model incorporates numerous variables such as stand density, intensive stand management prescriptions with their correspondent growth responses, as well as harvesting and transportation costs. These variables can be modified individually or simultaneously. An integrated Excel spreadsheet, incorporating the latest loblolly pine growth-and-yield models for the Lower Coastal Plain and publicly available cost data, was used to build the model. The model allows for the estimation of the mill-delivered cost of wood under various 'likely' scenarios. It, therefore, assesses the profitability of current and potential biotechnological advances. The model also has the ability to determine the land base required for a given size mill.

Multiple scenarios were explored in order to determine factors that optimize profitability and to suggest operating strategies. The findings show that more intensively managed regimes with higher growth rates increase marginal returns. In a commonly used fiber production regime returns were maximized at year 15, whereas returns in a wood production regime (with a thinning at age 10) were maximized at year 18.

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Abstract: In the marketplace, buyers of standing timber usually employ one of two basic business strategies once the timber is purchased; they either hold or liquidate the asset. In other word they may be buying for present consumption or holding to benefit from the growth and increases in value over time. These two distinct perspectives give rise to the two general approaches to timber stand valuation: 1) the determination of holding value or 2) the determination of liquidation value. Holding value is defined here as the current value associated with holding the timber to some designated future time. The liquidation value is simply the value if all merchantable timber is liquidated today.

The application of these two techniques tends to be related to stand age. Timber markets typically recognize that the value of young (premerchantable) stands is best estimated by some link to future timber value, a holding value approach. Likewise, markets generally recognize that as stands get older (and approach rotation age); their value is more appropriately represented by the liquidation value. Somewhere during the mid-rotation years, timber markets transition from one valuation approach to the other. Valuation during this transition period can be problematic. Some of these potential problems and possible solutions are discussed.

Financial Returns from Plantations Established Through the Conservation Reserve Program in Arkansas

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Abstract: In recent years government incentive programs such as the Conservation Reserve Program (CRP) have made planting trees a very economical and environmentally sensible option for lands, especially those in the South. The program's objectives are to help decrease soil erosion, increase water quality, and enhance wildlife on highly erodible cropland and other environmentally sensitive land through the use of cost shares and annual rental payments. Not only does the program meet its objectives, but it also provides those participants in the South who use the opportunity to plant commercial tree species with substantial income even after contract expiration. Using growth rates from studies conducted on loblolly pine and cherrybark oak in the Coastal Plain of Arkansas, financial returns were calculated for plantations established through the CRP. The heavy front end costs of establishing plantations are greatly reduced by the program through the use of cost shares and annual rental payments from the government, thus allowing landowners to increase their pre-tax internal rates of return.

Keywords: CRP, landowners, net present value

INTRODUCTION

Established by the Food Security Act of 1985, the CRP was designed to help decrease soil erosion, increase water quality, and enhance wildlife habitat on highly erodible croplands and other sensitive lands across the nation. The CRP has been beneficial to Arkansans who over the years have enrolled thousands of acres in this program. The objective of this paper is to calculate the financial returns from plantations established through the CRP.

METHODS

Growth rates of both loblolly pine (*Pinus taeda*) and cherrybark oak (*Quercus pagoda*) trees grown on quality, fertile sites in the coastal plain region of Arkansas were obtained from previous studies. Pelkki and Colvin (2003) documented growth rates of cherrybark oak trees grown on a coastal plain creek bottom in southwest Arkansas. The study used control plots (no treatments), thinned plots, and pruned/thinned plots with treatments occurring at years 21, 26, and 31. The first two thinnings reduced the stands to a 75 percent stocking level based on Gingrich's (1971) guide. The third thinning reduced the basal area within each treatment to 80 ft² per acre. In addition to the thinnings, the pruned stand was pruned to a height of 7 feet at age 10.

Williams (unpublished) documented growth of a loblolly pine stand near Bierne, Arkansas over a period of 60 years, with both thinned (treatment) and unthinned (control) plots. Though both stands were thinned at age 10 through removal of every other row and at age 14 through removal of every other tree; in the treatment stand at age 21 and 33 select thinnings were performed to remove poor growing trees.

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Using this data along with CRP incentive data, financial analyses can be calculated for lands enrolled in the CRP using three scenarios. The first two scenarios were for land enrolled in the general CRP which was planted to loblolly pine (thinned and unthinned) or cherrybark oak (thinned, unthinned, and thinned/pruned). The third scenario dealt with land enrolled in the continuous CRP program which was planted to cherrybark oak and overcup oak (*Quercus lyrata*). Costs for the analyses were determined using the Dubois et al (2000) publication for costs of forestry practices in the South, Arkansas Forestry Commission prices (2002) for tree seedlings, and Arkansas stumpage prices from TimberMart-South (2000). Average CRP rental and maintenance payments for 2000 were determined from the FSA website (FSA 2002).

Actual rental rates and maintenance payments for CRP land vary widely across the state depending upon the site, soil type, etc. For simplicity, an average annual rental rate of \$43.69 per acre along with a minimum annual maintenance payment of \$3 per acre for general sign-up and \$7 per acre for continuous sign-up were used. These rates were the averages for Arkansas in 2000. Management fees and taxes were assumed to be a liberal \$5.00 per acre for all calculations. Returns from the land only came from CRP payments during the contract and through thinnings and harvest cuts after contract expiration. Net present value (NPV) was calculated on a pre-tax basis. A real interest rate of 4 percent was used for all calculations. For the scenario with cherrybark and overcup oak trees, it was assumed that overcup oak would not be harvested, but simply be planted to meet continuous CRP program requirements.

RESULTS

For each scenario, net present value, soil expectation value, and internal rate of return were calculated. The costs for all scenarios included tax/management fees, site preparation, planting costs, seedling costs, and a final cruise cost. Returns during the contract period consisted of annual rental and maintenance payments. All thinnings were conducted after contract expiration and final harvests were clear fellings conducted during year 40 for all scenarios.

Loblolly pine plantation in the general CRP—For this scenario loblolly pine seedlings were spaced at 7.5' by 7.5' (774 trees per acre). The only returns received from the first 10 years were from the CRP, which paid \$43.69 per acre per year for the annual rental payment and \$3 per acre per year for maintenance payments, through year 10 when the CRP contract expired. Using growth rates from Williams (unpublished) valuations can be made for two treatments, thinned and unthinned. The unthinned stand had a NPV of \$1597.78 per acre. The cost associated with the thinned stand was a marking fee of \$27.71 per acre during years 21 and 33. This stand however produced a higher NPV (\$1653.24) than the unthinned stand. The stand enrolled in the CRP began making money by the second year of growth due to decreased initial costs which were minimized by the cost share and the first several years of rental payments.

Cherrybark oak in the general CRP—Cherrybark oak seedlings were planted on a 10' by 12' spacing on land which was assumed to be well suited to the species. Returns for the first 15 years were from the CRP, which paid \$43.69 per acre per year for the annual rental payment and \$3 per acre per year for maintenance, through year 15 when the CRP contract expired. Using the growth rates from Pelkki and Colvin (2003) for cherrybark oak, the NPV for the unthinned stand was \$796.34 per acre. The cherrybark oak stand that was thinned periodically at years 21, 26 and 31 had a higher NPV of \$1105.85 per acre at year 40.

Table 1 Summary of financial analyses for land enrolled in the CRP for a 40 year period.

		<i>Loblolly pine</i>		<i>Cherrybark oak</i>			<i>Cherrybark oak/ overcup oak</i>		
		<i>low intensity</i>	<i>high intensity</i>	<i>No thin</i>	<i>Thin</i>	<i>Thin & prune</i>	<i>No thin</i>	<i>Thin</i>	<i>Thin & prune</i>
NO CRP	NPV	\$1,104.04	\$1,141.51	\$136.90	\$447.17	\$333.34	\$100.95	\$39	\$17.92
	SEV	\$1,394.50	\$1,441.82	\$172.91	\$564.82	\$421.03	\$127.51	\$49.26	\$22.63
	IRR	10%	10%	5%	7%	6%	3%	4%	4%
CRP	NPV	\$1,597.78	\$1,653	\$796.34	\$1106.61	\$992.73	\$951.43	\$1,091.38	\$1,304.44
	SEV	\$2,018.14	\$2,087.89	\$1,005.85	\$1,397.75	\$1,253.97	\$1,201.74	\$1,378.51	\$1,306.59

A cost of \$27.71 per acre for marking the thinned stand prior to thinnings was incurred in the years 21, 26, and 31. The addition of pruning to a thinned stand of cherrybark oak trees decreased the NPV of the stand slightly to \$992.73 per acre. The costs incurred with this management technique included marking costs of \$27.71 per acre in years 21, 26, and 31 as well as a pruning cost \$84.70 per acre in year 10. Planting cherrybark oak trees on good sites even without the incentives the CRP offers, was also found to be a viable investment producing positive NPV for all three types of management and internal rates of return which remained above inflation.

Cherrybark oak and Overcup oak in the Continuous CRP—The continuous CRP is a program which allows more sensitive lands such as riparian buffers, to be enrolled at any time during the year with additional financial benefits. Lands enrolled in this program must meet specific enrollment qualifications and require slightly different planting practices.

At least two native hardwood tree species are required to be planted on continuous CRP land used for trees. For this scenario cherrybark oak and overcup oak trees were planted to meet this requirement. These trees were chosen based on their growth forms. Cherrybark oak trees were designated as the crop trees while overcup oak trees were planted to shade the boles of the cherrybark trees thus decreasing the probability of epicormic branching. Overcup oak trees were not harvested in this scenario. The planting spacing was 10' by 12' with equal numbers of overcup oak and cherrybark oak.

The first return from the land in the continuous CRP was received as a signing bonus of \$10 per acre per year of contract; so with a 15 year contract \$150 per acre was received for signing land into the program. The annual rental payment for land in this program was increased by 20 percent to \$52.43 per acre and received for the duration of the contract period, which in this case was 15 years. In addition to this, the annual maintenance fee was increased to \$7 per acre and the cost share was enhanced by 40 percent which brings the total cost share to 90 percent.

The unthinned stand produced a NPV of \$951.43 after the harvest of all crop trees. The thinned stand produced a slightly higher NPV of \$1091.38 per acre. Costs associated with the thinned stand included a marking fee of \$27.71 per acre in years 21, 26, and 31. Once again, the stand that was thinned and pruned did not produce as high an NPV as the thinned only stand (\$1034.44 per acre). In addition to the marking fees of \$27.71 per acre in year 21, 26, and 31, this stand had a pruning cost of \$42.35 per acre. The continuous CRP allowed landowners to plant two hardwood species on their lands at no cost through the use of enhanced cost shares, sign-up bonuses, and increased rental and maintenance payments. Without the program, planting hardwoods on these sensitive areas was not an economically feasible option according to the

NPVs for stands which are not thinned or stands which are thinned and pruned. The thinned stand produced a positive NPV of \$39 per acre and made an internal rate of return of 4 percent.

CONCLUSIONS

Making sound investment decisions in today's fluctuating stock market can be difficult. Investing in trees is one opportunity to consider especially for landowners who have highly erodible or sensitive land eligible for enrollment in the Conservation Reserve Program. This program makes it possible for landowners to reduce erosion, improve water quality, enhance wildlife habitat, and increase their returns on an investment while planting trees on their erodible land. This is especially true in the southern United States where growing conditions and good timber markets make this an opportunity not to be missed. Using the CRP to plant plantations of trees on qualified lands in Arkansas allows landowners to offset the high costs of establishment and increase pre-tax internal rates of return.

It was found that establishing plantations of loblolly pine and cherrybark oak through the CRP increased net present values, soil expectation values, and internal rates of return. Using the continuous CRP to establish a mix of hardwood trees such as cherrybark oak and overcup oak was also found to be a sound investment leaving the landowner with no-out-of-pocket expenses. Thinning stands occasionally throughout the rotation increased the NPV in each of the three scenarios. Pruning cherrybark oak trees during year 10 in the general CRP and the continuous CRP, though still producing a higher NPV than unthinned stands, decreased the overall returns. Unthinned stands had the lowest NPV for each scenario indicating that proper management throughout the rotation regardless of species (loblolly pine or cherrybark oak) increases the return on investment. Utilization of programs such as the CRP can help landowners begin a lifetime of fruitful timber investment opportunities as well as improve the overall quality of a site.

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Regional Differences in the Timber Resources and the Sawmill Industry in Pennsylvania

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Abstract: This study examines regional differences in the timber resources of Pennsylvania and the state's sawmilling industry. The northwest region of Pennsylvania contains a high volume of northern hardwoods with nearly 60% of the sawtimber being soft maple, black cherry, hard maple, beech, basswood, and birch. In contrast, nearly 65% of the timber resource in the southeast is yellow-poplar and red and white oaks. Northeast and southwest Pennsylvania contains more than 30% oak species, combinations of northern hardwood, and softwoods. More than one-third of the trees in the northwest and southeast are grades 1 and 2, but the value of the timber is higher in the northwest because of differences in the species composition and value of those species. The northwest also has the greatest timber volume and the highest timber density as measured by board feet of sawtimber per acre of all regions in the state. Variations in the value of the resource appear to influence the size and design of sawmills in the state. Mills in the northwest are larger and have higher levels of computerized optimization while the southeast has smaller mills and the lowest level of computerized optimization. Logs consumed by mills in the northwest were, on average, higher in grade and larger in diameter than those consumed in the southwest and northeast. Study results showed that mills in the northeast consumed logs of considerably smaller diameter than mills in other regions, which is consistent with the resource in this region.

Key Words: Hardwood, sawmill, timber resource

INTRODUCTION

The forests of Pennsylvania contained an estimated 7% of the eastern inventory of hardwood sawtimber in 1997 (Smith et al. 2001). These forests contain a variety of species and their composition varies widely within the state (Table 1). Pennsylvania also is the largest producer of hardwood lumber in the United States (USDC Dep. Commer. Bur. Census 2000). The hardwood lumber industry in PA is diverse in that it consists of mills that produce less than 100 thousand board feet per year to mills that produce over 40 million board feet annually. As with the state's timber resource, sawmill design and mill size varies by region. In this paper we explore the relationship between the hardwood resource and sawmilling industry in Pennsylvania and we examine how variations in the resource are associated with variations in the sawmilling industry.

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Table 1 -- Composition of Pennsylvania's sawtimber resource by region in 1989

Species	Northwest	Southwest	Northeast	Southeast	State
	-----percent ^{1/} -----				
Northern red oak	11.3	16.5	12.3	13.4	13.0
Other red oak ^{2/}	3.4	5.9	4.3	15.7	5.8
White oak	4.0	6.4	6.7	5.9	5.6
Other white oak ^{3/}	0.6	5.6	7.6	13.9	5.5
Yellow-poplar	2.9	7.3	1.1	15.7	5.0
Hard maple	10.2	6.6	9.1	1.0	7.9
Soft maple	21.1	11.5	14.0	5.4	14.8
Black cherry	18.5	11.5	5.7	1.1	10.9
Ashes	4.2	3.4	5.9	6.5	4.9
Basswood	1.1	1.3	1.9	0.8	1.3
Beech	7.2	2.8	5.1	1.3	4.9
Yellow birch	0.8	0.4	0.8	trace	0.6
Softwood ^{4/}	7.9	9.0	16.8	7.3	10.8

^{1/} Percentages do not add to 100 as not all species are included.

^{2/} Primarily black and scarlet oak.

^{3/} Primarily chestnut oak.

^{4/} Primarily hemlock and white pine

DATA USED

The four regions examined in this paper are used to develop Pennsylvania Woodlands Timber Market Report (Pa. State Univ. 1999). Forest inventory statistics for the counties within these regions were developed using the USDA Forest Service's forest inventory and analysis data base (<http://srsfia.usfs.msstate.edu/script/ew.htm>). Data on the sawmilling industry in Pennsylvania were obtained from a mail survey of sawmills in Pennsylvania in Fall 2000 (Smith et al. in press). Usable surveys were returned from 161 firms representing 172 mills. Survey results showed that several firms in northwest Pennsylvania operated more than one mill. The surveyed mills had a combined production of 542 million board feet in 1999 which represented 44% of the volume reported production for this state (USDC Dep. Commer. Bur. Census 2000).

Characteristics of Pennsylvania's Sawtimber Resource

In any given area in eastern hardwood region, the timber resource can be defined in terms of composition (Table 1); sawtimber volume, quality, and density (Table 2), and relative species value. In this study we separated timber quality into three groups using Forest Service tree grades: 1 & 2 (higher grades), 3 (midgrade), and 4 & 5 (lower grades). A key influence on timber grade and value is diameter at breast height (dbh). Timber density (timber volume per acre) is a proxy for relative timber availability (Luppold 1995). The value of species overtime has been variable (Luppold et al. 2001), but over the last decade black cherry, hard maple, and Northern red oak have been high value species.

Table 2 -- Characteristics of Pennsylvania's forest resource by region.

Class	Sawtimber inventory	Grades 1 & 2 trees		Grade 3 & 5 trees	Grades 4	Average	Timber
	mmbf	percent-----			diameter	density	
					in. dbh	bf/acre	
Northwest	23,797	35.0	38.6	26.4	17.1	3,477	
Southwest	14,052	31.4	35.4	33.2	17.2	2,010	
Northeast	20,129	30.3	38.0	31.7	15.9	2,513	
Southeast	8,740	35.1	32.7	32.2	17.6	1,401	
State	66,718	32.8	37.0	30.2	16.8	2,605	

The northwest region of Pennsylvania has the greatest volume of timber, a high percentage of grades 1 and 2 trees, the lowest percentage of lower grade trees, and the highest timber density (Table 2). By contrast, the southeast region contains the smallest amount of timber and the lowest timber density, but its percentage of higher quality trees is similar to that in the northwest. The northeast and southwest regions have similar volumes of high-grade trees and similar timber densities. However, the average dbh of timber in the northeast was less than 16 inches versus more than 17 inches in the other three regions.

Nearly 60% of the northwest sawtimber resource is soft maple, black cherry, hard maple, beech, and other northern hardwoods (Table 1). The single most dominant/prominent species is soft maple. While the price of soft "mainly red" maple lumber is moderately high (Hardwood Market Report 1999), only 18% of the red maple timber volume is in higher timber grades (Alerich 1989) causing the value of soft maple timber to be relatively low (Pa. State Univ. 1999). The northwest has the highest volumes of black cherry and hard maple vis-à-vis the other three regions and a significant volume of northern red oak.

The northeast contains a mixture of northern hardwoods, oak, and the largest softwood component (Table 1). The three most prominent hardwood species are soft maple, northern red oak, and hard maple. Hemlock and white pine are the most significant softwood species in this region. The southwest has similar volumes of oak and northern hardwoods and large volumes of yellow-poplar. This region has the greatest volume of northern red oak and a second highest volume of black cherry.

Nearly 65% of the southeastern is oak and yellow-poplar. Within the oak group, the less desired other red oaks (black scarlet) and other white oaks (chestnut) exceed the proportion of northern red and white oak. The percentage of higher grade trees in this region is largely due to the yellow-poplar which accounts for nearly half of the trees in grades 1 and 2 (Alerich 1989). Only 30% of the volume of oak species in the southeast is in higher grade trees.

Pennsylvania's Sawmilling Industry and Characteristics of Logs Consumed

The number and size of mills responding to the survey (Smith et al. *in press*) are shown in Table 3. The northwest had the highest number of multiple mill firms, level of production, and average mill size. The southeast had the smallest average mill size and lowest volume produced. It should be noted that regional variations in sawmill size in 1999 are roughly proportional to variations in timber density shown in Table 2.

Table 3 -- Number of sampled firms and mills, total regional lumber volume produced, and average size of mill.

Region	firms	Responding mills produced	Responding lumber	Volume of mill size	Average
	-----number-----		-----mmbf-----		
Northwest	37	44	245	5.57	
Southwest	47	49	125	2.55	
Northeast	38	39	103	2.64	
Southeast	39	40	68	1.70	
State	161	172	541	3.15	

The type of initial breakdown saw or "headrig" commonly characterizes hardwood sawmills as initial breakdown influences all subsequent "downstream" sawing activities. Downstream equipment (resaws, gangsaws, edgers, and trim saws), degree of automation, and level of computerized optimization also influence production capacity and efficiency. Large mills with band headrig tend to be oriented more toward the production of higher quality lumber and tend to use higher grade logs.

In an effort to examine hardwood mills in a consistent manner, we separated the survey data in terms of the percentage of firms with band headrigs, percentage of firms with at least one major saw with computerized optimization, and age of headrig (Table 4). The survey results show that many small band mills in Pennsylvania produce less than 1 million board feet per year. These smaller operations usually are relatively inexpensive portable band mills while the larger operations are capital-intensive permanent mills. Many responding small mills indicated that they use computerized optimization equipment, but such equipment is not comparable in cost or in production level of computerized equipment used in larger mills. Since there are large differences in the cost of computerized equipment between small mills and large mills, the percentages in Table 4 reflect optimization equipment in mills that produce a minimum of 1 million board feet per year.

In addition to having considerably larger mills, the northwest has the highest percentage of firms with band headrigs and the highest percentage of firms with computer optimization. If these percentages are adjusted for band mills that produced less than 1 million board feet per year, the percentage of mills having band headrigs for the northwest is reduced to 37%, while firms with band saws in the northeast and southwest decline to 15% and 7%, respectively (Table 4). Nearly half of the mills producing in excess of 1 million feet annually in the northwest use

computerized optimization equipment compared to about 25% in the southeast. Mills in the northwest also had newer headrigs on average than those in other regions.

Table 4— Characteristics of sawmilling firms in Pennsylvania and logs consumed by those firms.

Region	Firms with band headrigs ^{1/}	Firms with computer optimization ^{2/} in 1999	Average age of headrig logs	Higher grade logs	Medium grade logs	Lower grade log diameter	Average
	-----percent-----		years	-----percent-----			inches
Northwest	41 3/	48.6	8	58.4		21.8	19.8
Southwest	11	41.3	12	36.6		24.1	39.3
Northeast	17 4/	39.5	15	26.9		42.7	30.5
Southeast	19 5/	25.6	14	56.7		15.2	28.3

1/ Mills may have more than one headrig.

2/ Includes only mills that reported production exceeding 1 million board feet.

3/ Small band mills with production of less than 1 million board feet account for 3.4% of region's mills.

4/ Small band mills with production of less than 1 million board feet account for 2.1% of region's mills.

5/ Small band mills with production of less than 1 million board feet account for 11.9% of region's mills.

Logs consumed by mills in the northwest were on average higher in grade and larger in diameter than those consumed in the southwest and northeast. Northeast mills consumed logs of considerably smaller diameter than mills in other regions. The relative difference in the consumption of higher grade logs between regions also is consistent with relative differences in the proportion of higher grade trees in the regions (Table 1). However, the percentage of higher grade logs being consumed was greater than that of higher grade trees in the inventory in all four regions.

Trends concerning the quality of logs consumed and the quality of the resource in Pennsylvania are difficult to identify due to numerous factors that can influence this outcome. Tree and log grades are influenced not only by bole clarity but also by diameter. If mills purchase timber on sites with higher proportions of larger diameter trees or selectively harvest only larger trees, there could be a significant difference between the average diameter and grade of logs consumed versus timber in the inventory. Also in 1999 there were merchandising options for lower grade roundwood such as pulpwood and firewood for most areas of Pennsylvania. Finally, while an individual stem may contain several logs, we do not have information on what portion of the stem was removed, what was merchandised to other users, and what portion was left in the forest.

SUMMARY AND CONCLUSION

The northwest region of Pennsylvania contains the greatest volume of timber, has the highest timber density per acre, and currently the most valuable resource because of composition and tree grades. This region also has larger, more modern, and more technologically complex mills. By contrast, the southwest contains a similar proportion of high-quality trees as the northwest and has the highest average sawtimber diameter. However, timber density in this region is less than half of that of the northwest and the distribution and market value of the timber in the southwest is lower than in the other three regions. While the southwest does contain large mills, average mill size and technological complexity are less in this region than that in the other regions of PA.

Southwest and northeast Pennsylvania are similar in overall timber quality and density. This similarity extends to average mill size and level of technological complexity, though the northeast apparently has a higher percentage of mills with band headrigs. Regional variations in the quality of logs consumed seem to correspond to regional variations in resource quality, but the percentage of higher grade logs consumed is higher than that of higher grade trees in all regions.

While the relationship between the timber resource and sawmill size, design, and technical complexity appears to be influenced by variations in the resource, this relationship is conjoint in nature making it difficult to attribute specific mill characteristics to specific characteristics of the resource. For example, it can be argued that the high-quality/high-value resource in the northwest has contributed to larger, more technically complex mills yet timber density also may be an influential factor. Therefore, continual analysis of the relationship between the resource and the sawmilling industry is needed to sort out these conjoint relationships.

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Southern Forest Products Association 2001 Annual Mill Survey

Wade Camp, Southern Forest Products Association

The Southern Forest Products Association surveyed the southern pine sawmilling industry in early 2002 for the calendar year 2001. Forty-four mills responded (10% of total mills) representing 3.5 billion board feet of lumber (22% of total 2001 production), and 16.4 million tons of timber. The survey results found the following summary statistics:

Statistic:	<i>n</i>	1st Quartile	Average	3rd Quartile
2001 Sales Price	42	\$304	318	350
Chip price \$/ton	43	\$22.09	23.50	25.09
Cost of Chip-N-Saw \$/ton	35	\$38.00	40.95	44.90
Cost of Sawtimber \$/ton	30	\$52.06	56.65	60.42
Manufacturing Cost \$/MBF	41	\$71.86	92.00	105.05
Yield Tons per MBF	44	4.27	4.77	5.16

Frequency histograms with overlaid bell curves are used to display a total of 40 assessment statistics. Histograms show the frequency of respondents (vertical axis) within a class (horizontal axis), the higher the bar the more respondents. Bell curves provide measurements of skewness and kurtosis and show the variability within the data. Individual mill performance can be compared to other mills by locating its position along the bell curve or cumulative percentile distributions. Competitive assessment of both operating efficiencies and business performance of inter-region mills can be achieved. Aggregate income statements can be built providing industry-wide averages, lower intervals, and upper intervals for lumber sales realization, by-product revenue, raw material, labor, and manufacturing costs. Using data from other sources, assessments of other, non-southern pine producing regions can be achieved. Quartile and percentile rankings are provided for many statistics. Quartiles are numbers that divide ranked data into equal quarters. The first quartile represents the lowest 25%. The second quartile (median) represents the middle. The third quartile represents the highest 25%. Sometimes it is beneficial to be in the first quartile (costs) and sometimes in the third quartile (sales price).

Other assessments sample a small portion ($n \leq 15$ mills) of the industry. The objective of this project was to perform a census and make statistical inferences about the population. The Student's *t* distribution method is used to estimate the upper and lower intervals in which the true population average is located. The probability of the true population average within the interval is 95%. If the survey were repeated many times, 95% of the intervals would include the true average. This method provides readers a way to compare their mill results against industry-wide results and measuring the variance within the data. In some cases it is best to compare mills of similar size, log diameter, breakdown equipment, and geographic area. In those cases a cluster analysis was performed.

Total Factor Productivity Measurement with Improved Index Numbers

SoEun Ahn¹ and Robert C. Abt

Abstract: The objective of this study is an empirical application of improved index numbers to the computation of total factor productivity (TFP). We calculate our price, quantity, and TFP index numbers employing Fisher ideal index formula. Fisher index is consistent with a flexible aggregator function and has the property of self-duality. Self-duality warrants direct Fisher quantity index based on actual observed quantities is the same as the indirect quantity index number derived by deflating the values with Fisher price index. The property of self-duality is particularly desirable in practice since the most available forms of data are values not actual quantity levels. Our application is to sawmills and planing mills industry of U.S. (Standard Industry Classification 242) using national annual time series data covering the period of 1947 – 2000. The results show that TFP increases from 0.69 to 0.99 over the analysis period, indicating that the industry experiences 0.56 percent of average annual growth rate during the past 50 years.

Key Words: Total factor productivity, Fisher index, Self-duality, Sawmill industry

INTRODUCTION

Among various techniques to examine the performance of the firms, total factor productivity (TFP) provides a simple, yet comprehensive measurement. Total factor productivity (TFP) measures changes of total output associated with changes of all input uses and can be represented as the ratio of output to an input quantity index numbers. Although the computation of TFP is conceptually simple, the application requires extensive data on output and input quantities and prices. In practice, quantity index numbers are typically generated by deflating the values (e.g. receipts of output or expenditures on input uses) with price index due to the lack of data on actual quantities. Many previous studies choose published price index such as producer price index (PPI) by Bureau of Labor Statistics (BLS) as a value deflator. Commonly used index formulas include Laspeyres, Paasche, Fisher, and Tornqvist formulas.

The objective of this study is an empirical application of improved index numbers to TFP measurement. We calculate price index numbers with chain-type Fisher formula and use them as value deflators without employing published price index numbers, where they are most likely constructed with fixed year-base Laspeyres formula. Fisher index is consistent with a flexible aggregator function and has the property of self-duality. Self-duality warrants direct Fisher quantity index based on actual observed quantities is the same as the indirect quantity index number derived by deflating the values with Fisher price index. The property of self-duality is particularly desirable in application given that the most available data are likely to be the values. Our application is to sawmills and planing mills industry of U.S. (1987 Standard Industry Classification 242) using national annual time series data covering the period of 1947 – 2000.

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Index Number Theory

A construction of indirect quantity index numbers relies on the premise that value change can be solely decomposed into price and quantity changes. If the premise holds, the value index can be represented as a product of price and quantity index numbers:

$$(1) \quad \mathbf{p}_t \cdot \mathbf{x}_t / \mathbf{p}_s \cdot \mathbf{x}_s = P(\mathbf{p}_s, \mathbf{p}_t, \mathbf{x}_s, \mathbf{x}_t) * Q(\mathbf{p}_s, \mathbf{p}_t, \mathbf{x}_s, \mathbf{x}_t)$$

where, \mathbf{p}_s and \mathbf{p}_t are vectors of prices in reference period s , and current period t , respectively. \mathbf{x}_s and \mathbf{x}_t are corresponding vectors of quantity. $\mathbf{p} \cdot \mathbf{x}$ is a inner product of price and quantity vectors. Once price index numbers are given, we can derive indirect quantity index numbers using the relationship in (1). Two important price index number formulas, Laspeyres and Paasche index, are defined as below:

$$(2) \quad P^L(\mathbf{p}_s, \mathbf{p}_t, \mathbf{x}_s, \mathbf{x}_t) \equiv \mathbf{p}_t \cdot \mathbf{x}_s / \mathbf{p}_s \cdot \mathbf{x}_s$$

$$(3) \quad P^P(\mathbf{p}_s, \mathbf{p}_t, \mathbf{x}_s, \mathbf{x}_t) \equiv \mathbf{p}_t \cdot \mathbf{x}_t / \mathbf{p}_s \cdot \mathbf{x}_t$$

From (2) and (3) it is clear that Laspeyres and Paasche price index numbers, in some way, depict two extremes in constructing weights in formulas. Laspeyres price index emphasizes on the quantities of base period, and Paasche price index on the quantities of current period. A natural alternative is a combination of these two index numbers resulting Fisher price index, which is a geometric mean of Laspeyres and Paasche index:

$$(4) \quad P^F \equiv \left[\frac{\mathbf{p}_t \cdot \mathbf{x}_s * \mathbf{p}_t \cdot \mathbf{x}_t}{\mathbf{p}_s \cdot \mathbf{x}_s \quad \mathbf{p}_s \cdot \mathbf{x}_t} \right]^{1/2}$$

Another important price index is Tornqvist formula, which is defined as a weighted geometric mean of price relatives where weights are simple mean of the value shares of i ($i = 1, \dots, n$) commodity in a group in base period s and current period t :

$$(5) \quad P^T \equiv \prod_{i=1}^n \left[\frac{p_{it}}{p_{is}} \right]^{\frac{w_{is} + w_{it}}{2}}$$

It can be algebraically shown that there are dual relationships between price index numbers and resulting indirect quantity numbers. For example, Paasche quantity index numbers are generated using Laspeyres price index as a value deflator. Among the four index formulas introduced above, only Fisher index numbers have the property of self-duality. The property of self-duality (sometimes referred to as factor reversal test) assures that the product of price and quantity index numbers computed with the same formulas equals to the value ratio (i.e. price and

quantity index numbers in (1) are derived from same formulas), indicating that Fisher price and quantity index numbers together decompose value index exactly.

It is well established that each quantity index number is consistent with a particular aggregator function (i.e. production function). For example, Laspeyres quantity index is consistent with Leonfief aggregator function while Paasche index is with linear aggregator function. Tornqvist index is exact to translog aggregator function whereas Fisher is to a quadratic aggregator function. Diewert (1976) name index numbers “superlative” if they are exact for flexible aggregator functional forms. An aggregator functional form is said to be flexible if it can provide a second order approximation to an arbitrary twice-differentiable linearly homogeneous function.

One implication of this definition is that all superlative index numbers are likely to be very similar in the magnitudes since they approximate any arbitrary twice-differentiable function. Both Tornqvist and Fisher index numbers are superlative. Later, Diewert (1992) used a test (or axiomatic) approach to index number theory and discovered Fisher index numbers satisfied more tests than any other index numbers, thus, he recommended the use of Fisher index numbers in applications.

Another taxonomy of index numbers is fixed-year base verses chain-type index numbers. As described above, index numbers measure the changes in a set of related variables from a reference year. Index constructed in reference to a particular year is named “fixed-year base” index numbers. An alternative to fixed-year base index is “chain-type” index numbers. The chain type index numbers first calculate annual changes where index numbers of current year t are derived based on the previous year $t-1$ as reference year. These annual changes, then, are multiplied to represent the changes over a given time period. As formally stated:

$$(6) \quad I(0,t) = I(0,1) * I(1,2), \dots, * I(t-1,t)$$

where, $I(t-1, t)$ is any index number computed for year t with reference year $t-1$. The comparison between year t and reference year 0 can be done by the product of chained index numbers computed for consecutive years in (6).

Fixed-year base index numbers are easy to compute and require less information (e.g. value weights for fixed-year base Laspeyres index numbers remain the same for all periods). However, chain-type index numbers are recommended in practice, especially in respect to productivity measurement. Since chain-type index numbers only concern changes over consecutive years, they measure relatively smaller changes, implying some of the approximations involved in the derivation of theoretically meaningful index numbers are more likely to be held (Coelli *et al.*, 1998).

Application to Sawmills and Planning Mills Industry of U.S.

Our application is to sawmills and planning mills industry of U.S. (1987 Standard Industry Classification System: 242) and nation-wide annual time series data covering year 1947-2000 are constructed. The main sources of the data are Census of Manufactures (CM) for census years and Annual Survey of Manufactures (ASM) for non-census years published by Bureau of the Census. Census of Manufactures reports various statistics of industry group and is conducted in every 5 years. ASM provides sample estimates of statistics for all manufacturing industry between census years. Both CM and ASM use SIC system for the definition of industry. SIC system has been redefined over the years, and major changes related to sawmills and planning mills industry occurred in 1958 and 1967. In 1997 Bureau of the Census

introduced new industry classification system, North American Industry Classification System (NAICS), and replaced SIC system. For this study, we select the industry definition based on SIC system defined in 1987, and all values from CM and ASM have been adjusted according to the regrouping of subcategories of industry in 1958, 1967, and 1997. We describe the construction of each variable below. All index numbers are generated with chain-type Fisher formula.

Lumber Output

We collect lumber prices and productions by species groups (softwood and hardwood) and regions (Adams et al. 1988, Adams 2003). For the softwood, prices are aggregated with weights on regional productions to generate a national softwood lumber price series. Hardwood lumber price series vary greatly by species and regions, and observed time series data dates back to only 1965. Nominal hardwood lumber price series prior to 1965 is recovered from multiplying the observed price in 1982 by hardwood lumber producer price index (BLS, 1982=1.00), restoring prices before they are converted into index numbers. Constructed lumber prices of softwood and hardwood series are aggregated with value weights to produce the national combined lumber price index numbers. Output quantity index numbers are created by deflating total values of output (values of shipment) of the industry with price index numbers computed above.

Labor Input

CM and ASM report various information on labor use. Labor is divided into the production labor and non-production labor. The implicit price of production labor per hour is calculated by dividing the adjusted total wages to include fringe benefit payment by the total number of production hours worked. To compute the total number of non-production hours worked, total number of production workers are subtracted from total number of employees and assume 2000 hours per worker and year. Subtracting the adjusted total wages from the adjusted total payroll returns the total labor cost of non-production labor. The implicit price of non-production labor, then, is computed by dividing the total non-production labor cost by total number of non-production hours worked. Quantity index numbers of labor are derived by deflating labor cost by corresponding price index numbers computed above.

Energy Input

Costs of electricity and fuel of the industry SIC 242 are available in CM and ASM from 1967. Between 1958 and 1967, only total cost of energy (electricity and fuel combined) is reported in ASM, however, the disaggregated cost of energy is obtainable in the census years for the industry during this period. The total cost of energy is split into cost of electricity and fuel using the cost ratio of the each to total cost in the census year nearby to retrieve the separate cost series between 1958 and 1967. Before 1958, data on the cost of energy is available only at higher aggregated industry level, lumber and wood product (SIC 24). We compute the ratios of electricity and fuel cost of SIC 242 to the counterparts of SIC 24 in 1958 CM. The computed ratios are, then, applied to the costs of electricity and fuel of SIC 24 for the years before 1958 to recover the cost series of SIC 242. Implicit price of electricity is calculated by dividing the cost of electricity by the total quantity of electricity used. Prices of fossil-fuel-composite are used as annual average price of fuel and are obtained from Annual Energy Review published by Energy Information Administration. A single price index number of energy is determined by

aggregating electricity and fuel with the weight of each cost on total cost. Quantity index numbers are generated using calculated price index numbers of energy.

Wood Input

CM and AMS provide the cost of materials used to produce the output. Given that the high percentage of raw materials put into the production of sawmills and planing mills industry, non-energy cost of materials (i.e. the remainder of costs after subtracting cost of energy from the total material costs) is used as the expenditure on wood.

Since historical saw-timber price (e.g. delivered prices of log to sawmills) series are not available except recent years to our knowledge, the sum of stumpage price and logging and haul cost is used as a proxy for the price of saw-timber. For the softwood, the stumpage prices and logging cost by regions are assembled along with saw-timber harvest levels. Prices are aggregated with weights on regional harvest levels to generate a national softwood saw-timber price series. For hardwood, we gather the stumpage prices and logging cost by regions for 1965-2000. Information, however, on regional harvests is not available, thus, the regional lumber productions are used as weights to aggregate regional stumpage prices and logging cost. We apply the same technique used in hardwood lumber price series to construct the hardwood saw-timber price series for the years where data are not available. Prices of softwood and hardwood are aggregated with the weights on lumber productions by species groups to compute single saw-timber price series.

Capital Input

Capital quantity index numbers are measured in three stages. The first stage is to estimate capital stock in constant dollars for asset groups. In the second stage, the rental prices (user cost) of asset groups are estimated and expressed in rates per constant dollar of productive capital stock. Lastly, rental prices are multiplied by stock estimates, and the results are summed over asset groups to calculate the total capital costs. The estimates of capital stocks are aggregated across asset groups using cost shares of each asset group on total capital cost.

Productive stock estimates of depreciable goods are constructed using perpetual inventory method (PIM). Perpetual inventory method measures productive stocks at the end of year equal to the weighted sum of all past investment, where the weights are relative efficiency of asset at the given age to a new asset. As stated formally:

$$(7) \quad K_t = \sum_{\tau=0}^{\infty} \delta_{\tau} I_{t-\tau}$$

where, K_t is the estimate of stock at the end of year t , τ is age of asset, δ_{τ} is the relative efficiency function at age τ , and I is investment. The relative efficiency function is a schedule of quantity of service provided by asset at a given age relative to a new asset. Hyperbolic efficiency function is adopted as follows:

$$(8) \quad \begin{aligned} \delta_{\tau} &= (L - \tau) / (L - \beta\tau) & 0 < \tau < L \\ \delta_{\tau} &= 0 & \tau > L \end{aligned}$$

where, L is a service life of asset, and β is the decay parameter which determines the shape of curvature of efficiency function.

We retrieve the end of year investment data on aggregated asset group, equipment and structure, from CM and ASM to year 1947. Since PIM requires the data on investment a far prior to 1947, we construct investment data of SIC 242 prior to 1947 using National Income and Product Account (NIPA) investment data on SIC 24. We compute the ratios of SIC 242, separate series of equipment and structure, to the counterparts of SIC 24 from ASM. These ratios are, then, applied to NIPA investment series of SIC 24 to estimate SIC 242 series for the years between 1901 and 1946. Following BLS (1983), we select decay parameter β equal 0.5 for equipment, and 0.75 for structure. Average service lives chosen for equipment and structure are 16 and 28, respectively.

Next, we derive rental prices (or user cost) for equipment and structure based on the formula as below:

$$(9) \quad c_t = Tax_t * (p_t r_t + p_t d_t - (p_t - p_{t-1}))$$

$$\text{where, } Tax_t = (1 - u_t z_t - e_t) / (1 - u_t)$$

where, c_t is rental price expressed in rates per constant dollar of productive capital stock, p_t is the deflator of new capital good, r_t is the internal rate of return on capital, d_t is the average rate of economic depreciation, $(p_t - p_{t-1})$ is the revaluation of assets due to inflation in price of new goods. The Tax_t reflects the effect of various taxes where u_t is the corporate income tax rate, z_t is the present value of \$1 of tax depreciation allowances, and e_t is the effective rate of the investment tax credit.

We use all tax information of SIC 24 prepared by BLS due to the lack of historical data in three-digit SIC industry level. We suppose that the tax rates for industry SIC 24 are not likely much different from those for SIC 242. Rental prices are computed using equation (9) for the each asset group: equipment and structure. The rental prices of equipment and structure are multiplied by its corresponding stock estimates to obtain the total capital cost, and cost share of each asset group is computed accordingly. Stock estimates of equipment and structure are combined to generate an aggregated capital quantity index numbers using the cost shares computed above.

Productivity Measurement

Total factor productivity is measured the ratio of output to an input index numbers. We include one aggregated output (softwood and hardwood combined) and five inputs: production labor, non-production labor, energy, wood, and capital inputs. All inputs are aggregated with weights on cost shares on total cost of production to generate a single aggregated input index.

RESULTS AND DISCUSSION

As a sensitivity analysis, we calculate our index numbers using Laspeyres, Paasche, Fisher and Tronqvist index formulas to investigate the differences among them. The results assure our expectations. The magnitudes of Fisher and Tornqvist index numbers are very similar to each other over all price, quantity, and TFP index numbers. However, we find some discrepancies between superlative index numbers (Fisher and Tornqvist index) and Laspeyres or Paasche index. We refer to Ahn (2003) for more detail on comparisons among index number formulas.

All chained-type Fisher price index numbers (1996 = 1.00) are shown in Figure 1. The prices of lumber demonstrate steady, yet continuous increases over the years with exceptions of

jumps in late 70s and early 90s. Lumber prices have stabilized since the 90s. Both production and non-production labor prices climb more than twelve folds over the last 50 years. Trend in production labor are relatively smooth compared to non-production labor prices. Price index numbers of energy remain relatively stable until early 70s and begin to increase rapidly due to the energy crisis in late 70s and peaked in 1985. After the big boosts in late 70s and early 80s, energy prices are settled down displaying a little variation. Price index numbers of wood input show consistent increases in price over time. Across output and the all inputs, we observe consistent and smooth increasing trends until late 70s in general and more dynamics in 80s and 90s, especially with energy and capital inputs.

Figure 2 reports quantity index numbers for output and all inputs. Quantity index numbers of lumber exhibit fluctuations with constant increases over time. Quantity index numbers of production labor display the mirror image of price index numbers, indicating the cost of production labor has stayed relatively the same over the years. They show continuous falls until late 80s and are stabilized after that, implying that the industry moves toward labor-saving production as labor price increases. In contrast to production labor, non-production labor quantity index numbers do not exhibit much variation. They show a rather uniform level of quantity; fluctuate around 1.00 over whole period.

Quantity index numbers of energy show a good deal of variation until the late 60s, yet their ranges confined to 0.50 and 0.90 and, then, jump to the all-time peak 1.15 in 1971 from 0.55 in 1970. Energy uses increase sharply until 1976 and, then, begin to subside due to steep increase in energy price in the late 70s. The small but consistent increases are followed from 80s. Indirect quantity index numbers of wood input report consistent increases until mid 80s, bounce-ups in late 80s, slight decline in early 90s, and moderate increase in recent years. Note that quantity index numbers of wood input follow closely lumber quantity index numbers due to high percentage of wood input in the production of lumber.

Figure 1. Price index numbers of output and inputs (1996=1.00)

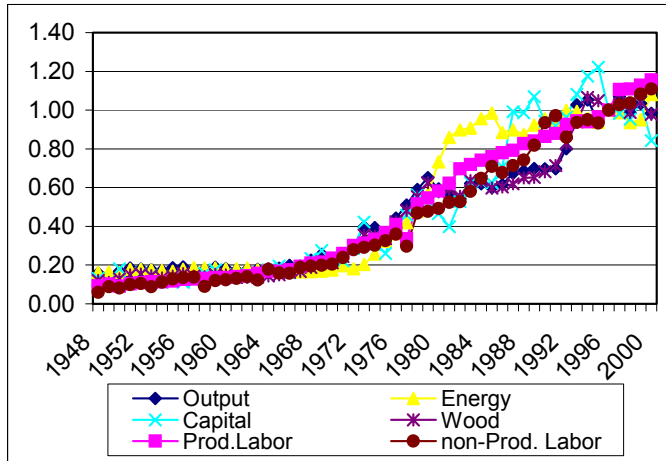
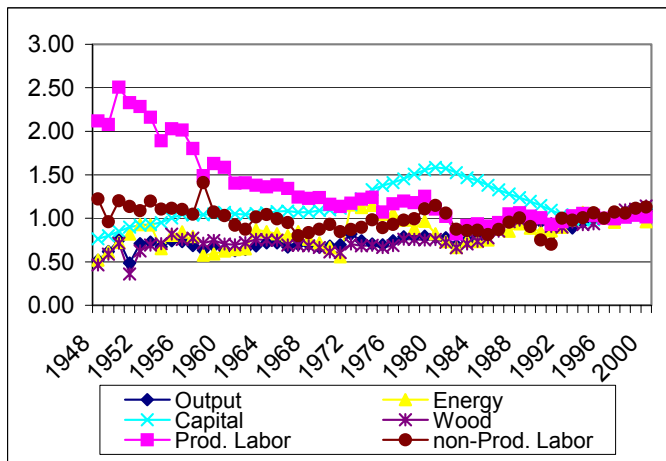
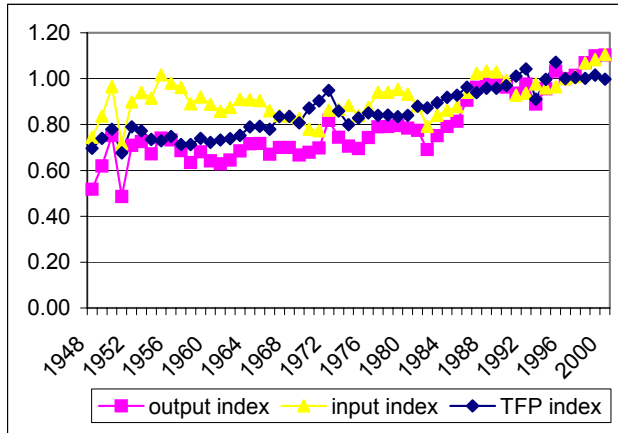


Figure 2. Quantity index numbers of output and inputs (1996=1.00)



A notable fact in the comparison of quantity index numbers among inputs is the relationship between labor and capital input uses. If the capital is a truly substitute for production labor in the sawmill industry, one would expect a negative correlation between labor and capital input uses. In Figure 2, labor and capital quantity index numbers form a shape similar to a mirror image, suggesting they are negatively correlated. Up to year 1980 the labor input uses, as expected, have diminished significantly while the capital uses show rather steady increases over the years, indicating that the substitution between labor and capital may not be

Figure 3. Total Factor Productivity, output, and aggregated input index numbers



as strong as one expect in sawmill industry. After 1980, the trends are reversed, capital input uses turn into significant downfalls, while labor uses remains relatively unchanged with even slight increases in some years.

Total productivity index numbers along with output and aggregated input index are presented in Figure 3. Over the last 50 years, TFP index numbers are increased from 0.69 in 1948 to 0.99 in 2000. TFP index numbers show little variations until the late 60s, and sharp increases in 1970 and 1971. After a boost in early 70s, TFP display a significant fall then show a small yet constant increases over the years. Annual average growth rates are also computed by the each decade. The industry demonstrates the highest average annual growth rate of 0.018 in 1960s, followed by 0.014 in 1980s. In 1950s and 90s, TFP shows a nearly zero annual growth, even negative in 1970s.

Constantino and Haley (1989) reported annual growth rate of 1.24 percent for sawmills in Douglas-fir region of U.S. over the period 1957-1982. Abt *et al.*, (1994) found that U.S. West and South undergone 1.6 and 1.3 percents of growth in TFP, respectively, over the periods of 1965-1988. They also found negative annual growth rates in 70s. In our study, the results indicate that saw mills and planning mills industry in U.S. experiences 0.56 percent of average annual growth rate during past 50 years. Our estimate of overall annual growth rate of the industry is rather smaller than estimates found in previous studies, yet it can be explained, in part, that we cover longer periods and estimate almost zero growth rate in 90s.

Nevertheless, considering that even agricultural sector productivity is managed to show nearly 2 percent of average annual growth rate over the period of 1948 – 1994 (Ball *et al.*, 1997), the U.S. sawmill industry exhibits virtually no growth in the past half century. However, it should be noted that the part of overall productivity gains could come across industries. For example, the recent expansion of engineered wood products, which are substitutes for the lumber, may cause the shift of productivity gains to these industries.

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Wildland fires: What to blame?

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Abstract: This study investigates the causality relationships among wildland fires, El Niño/Southern Oscillation (ENSO), timber harvest, and urban sprawl in the United States using vector autoregression. Our results indicate that an individual factor may not significantly contribute to wildland fire activity when acting alone, but could trigger fire occurrence when coupled with other factors. ENSO, timber harvest, and urban sprawl are all found to influence wildland fire activity when they are considered jointly. Area burned is more significantly affected by ENSO than the number of wildland fires. The impulse response functions suggest that the impact of an ENSO event on wildland fire activity could last more than a decade before gradually dying out. A unit increase in ENSO anomalies would reduce the number of wildland fires by as much as 8% initially and cause area burned to decrease by 4.7% in the first year and then to increase by 2.5% before returning to the original path. The complex causality interrelationships create challenges for and call for a systematic approach to wildfire fire mitigation and management.

Key Words: Wildland fire activity, Granger causality, vector autoregression, impulse response.

INTRODUCTION

Wildland fires can pose severe threats to property, life, and the environment, engendering far-reaching costs and losses to society (Butry et al. 2001), while playing an important role in the dynamics of forest ecosystems. To alleviate the detrimental impact of wildland fires requires holistic and effective fire management and prevention plans, which rely on our knowledge of factors influencing wildland fire activity. Many factors can contribute to the occurrence of wildland fires. One of the widely recognized causes of wildland fires is probably weather or climatic changes such as El Niño/Southern Oscillation (ENSO). Climatic changes resulting from ENSO events alter vegetation/fuel development and lightning (a major wildland fire ignition source) occurrence, affecting wildland fire risks. Studies have found that ENSO is highly correlated with wildland fires in the U.S. (Simard et al. 1985, Swetnam and Betancourt 1990, Brenner 1991, Chu et al. 2002).

Timber harvest may also affect wildland fire activity. On one hand, timber harvest can play a critical role in mitigating forest fires (Dombeck 2000). Harvest removes biomass/fuels from forestland, reducing fire risks and the intensity of fires if ignited. Harvest also causes the fragmentation of fuel distribution, creating barriers to fire spreading. On the other hand, logging slash and residues may be more susceptible to fire. Meanwhile, machinery operation and human disturbances resulting from harvesting may also increase the probability of fire occurrence. Timber harvest, which affects forest structure, local microclimate, and fuel accumulation, may also increase fire severity (Center for Water and Wildland Resources 1996).

Another factor that has potential impacts on wildland fires is urban sprawl. From 1960 to 1990, urban population density declined by over 30% while the urban population increased by

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almost 50% (US Census Bureau 1993). Urban sprawl has increased the complexity and severity of wildland fires. Urbanization has led to landscape fragmentation (Alig et al. 1999), increased fire suppression efforts (Irwin 1987), and escalated human interventions with wildland (Plevel 1997). All these potentially affect the intensity and occurrence of wildland fires (Keeley et al. 1999, Monroe 2003).

Other factors have also been linked to wildland fires. Studies on fire behavior have identified that in addition to weather, fuel composition, topography, and moisture are related to fire spread and intensity (Rothermel 1972, Anderson 1982). Forest fire history reveals that anthropogenic change and the degree of stand/fuel development have an influence on wildland fire occurrence (Weisberg and Swanson 2003). Geographic location (latitude) explains most of the variability in human-caused wildland fires in the eastern United States (Donoghue and Main 1985). Fire suppression may lead to fewer, but larger and more intense fires (Rothermel and Philpot 1973). Areas that have been burned would be less likely to be burned again within about a decade (Prestemon et al. 2002). And demographics are found to have no significant impact on wildland fires (Zhai et al. 2003).

These previous studies identified various possible causes of wildland fires based on local or regional case studies. Yet, few studies have explored the subject at the national level. Local and micro-level studies may be insufficient for providing national policy recommendations on large-scale wildland fire prevention and management because many factors affect wildland fire activity and their impacts often vary at different landscape levels. More importantly, these previous studies generally ignore the potential endogeneity of relevant variables, particularly the feedback effects of wildland fires on other variables. The feedback effects between wildland fires and other variables are evident. Wildland fire risks could influence decisions on forest management (Rideout and Omi 1990) and timber harvest (Martell 1980, Reed 1984, Yin and Newman 1996). Wildland fires, which cause carbon emissions to the atmosphere (Carcaillet et al. 2002), may contribute to climate change as well. And wildland fire risks may also affect lifestyle choices including decisions to live in or close to forested areas. Ignorance of the interactions among wildland fires and other factors may introduce biases to the results. Though the correlations between fires and ENSO events showed that ENSO and wildland fires were connected, these studies did not indicate their causality relationships and overlooked the impact of other factors on wildland fires. Furthermore, most of the existing studies look at only the one-time or immediate effects of assumed exogenous variables on wildland fire activity. These effects may not be instantaneous or short-lived, rather may last quite a long period in some cases. For instance, an ENSO event may influence weather patterns for several years. Even a one-time weather change could affect vegetation dynamics for many years to come, leading to potential long-lasting impacts on fuel development and wildland fire activity.

In this article, we seek to address these limitations of previous studies. By drawing upon existing findings on factors influencing wildland fire activity, this study further examines the interrelationships between wildland fires and major factors that potentially interact with wildland fire activity at the national level. Their interrelationships are determined simultaneously and without limiting the directions of causality in the first place. Because many factors may be related to wildland fires, to consider all of them is impossible and may not generate meaningful results due to the limitations of data and analytical tools. Instead, we focus on three major factors: climate/weather (ENSO in particular), timber harvest, and urban sprawl. These factors have been considered to have potential impacts on wildland fire activity as discussed earlier, and they also represent major human and natural driving forces for forest landscape changes over

time, particularly in recent decades. The estimated interrelationships would provide an insight into the causality among wildland fires, ENSO, timber harvest, and urban sprawl. In addition, the impulse responses to an ENSO event are also derived to identify its temporal effect on wildland fire activity.

METHODS

To account for the interrelationships among wildland fires and other variables, vector autoregression (VAR) was used in this study. In a VAR model, relationships among different variables are simultaneously determined (Hamilton 1994, Enders 1995). A VAR analysis usually involves the determination of variables to be included and appropriate lags. As mentioned earlier, four variables are considered in this analysis. The standard form of the VAR model can be expressed as

$$\begin{aligned}
 \ln(F_t) &= \alpha_{10} + \sum_{\rho=1}^n (\alpha_{11\rho} \ln(F_{t-\rho}) + \alpha_{12\rho} \ln(H_{t-\rho}) + \alpha_{13\rho} \ln(UPD_{t-\rho}) + \alpha_{14\rho} MEI_{t-\rho}) + \varepsilon_{1t} \\
 \ln(H_t) &= \alpha_{20} + \sum_{\rho=1}^n (\alpha_{21\rho} \ln(F_{t-\rho}) + \alpha_{22\rho} \ln(H_{t-\rho}) + \alpha_{23\rho} \ln(UPD_{t-\rho}) + \alpha_{24\rho} MEI_{t-\rho}) + \varepsilon_{2t} \\
 \ln(UPD_t) &= \alpha_{30} + \sum_{\rho=1}^n (\alpha_{31\rho} \ln(F_{t-\rho}) + \alpha_{32\rho} \ln(H_{t-\rho}) + \alpha_{33\rho} \ln(UPD_{t-\rho}) + \alpha_{34\rho} MEI_{t-\rho}) + \varepsilon_{3t} \\
 MEI_t &= \alpha_{40} + \sum_{\rho=1}^n (\alpha_{41\rho} \ln(F_{t-\rho}) + \alpha_{42\rho} \ln(H_{t-\rho}) + \alpha_{43\rho} \ln(UPD_{t-\rho}) + \alpha_{44\rho} MEI_{t-\rho}) + \varepsilon_{4t}
 \end{aligned} \tag{1}$$

where

F_t = the wildland fire activity at time/year t , measured by the number of wildland fires or area burned (ha);

H_t = the amount of timber harvested at time/year t (m^3);

UPD_t = the urban population density at time/year t (people/ km^2);

MEI_t = the multivariate ENSO index value at time/year t ;

α = the regression coefficients to be estimated;

ρ = the order of the VAR or the lag number; and

ε = the disturbance terms.

Here wildland fire activity was measured using two indicators: the number of wildland fires (NF) and area burned (A). As a result, two sets of VAR models were estimated, one examining the number of wildland fires and the other analyzing area burned. The data for the number of wildland fires and area burned annually were derived from the National Interagency Fire Center (2003). The timber harvest represented by the amount of roundwood production was obtained from the FAOSTAT database (FAO 2003). The Multivariate ENSO Index (MEI) was used to measure ENSO events. MEI is based on six main observed variables of ENSO events over the tropical Pacific. These variables include sea-level pressure, zonal and meridional components of the surface wind, sea surface temperature, sea air temperature, and total cloudiness fraction of the sky (Wolter and Timlin 1993). MEI measures both strength and directions of ENSO episodes. Positive MEI values represent the warm ENSO phase (El Niño); negative MEI values indicate the cold ENSO phase (La Niña). The MEI series of May-June was used in the analysis. Using the May-June MEI series rather than the annual average was to avoid the inappropriate cancellation of positive and negative MEI monthly values during some active,

yet irregular ENSO years. The month of May-June was chosen because it was associated with the early to middle stage of the wide-spread regional fire seasons across the country (Edmonds et al. 2000). The MEI data were obtained from the National Oceanic and Atmospheric Administration (NOAA 2003).

The complexity of urban sprawl posed a difficulty in measuring it, especially with a single indicator. However, urban expansion in the U.S. in the past several decades has been characterized by increased urban population and urban land area (US Department of Housing and Urban Development 1999). To incorporate these two important characteristics in the VAR analysis and to choose a measure that has proper meaning, urban population density derived from census data was used as a proxy for urban sprawl. Urban population was calculated based on the annual population estimates (US Census Bureau 2000) and percentage of urban population (US Census Bureau 1993, 2003). Existing data on urban land area (US Census Bureau 1993, 2003, Vesterby and Krupa 2001) were not reported on an annual basis, but in an interval of 4-5 years. Linear interpolations were used to recover the missing data. Urban areas refer the places with a population of 2,500 or more. All the data series cover the period from 1961 to 2000. Except MEI, all other series were transformed to logarithmic values.

Before estimating the VAR models, the stationarity of the data series was analyzed using unit root tests (Dickey and Fuller 1979, 1981) to better understand the data generation process. However, even if a unit root was detected for a series, it was not detrended in the VAR analysis for two reasons. First, detrending may “throw away” information concerning comovements in the data. Second, the purpose of VAR analysis is to determine the interrelationships among the variables, not the parameter estimates. Therefore, there is no need for detrending in a VAR analysis (Sims 1980).

We started with the quadrivariate VAR model of seventh-order lags, the maximum allowable lags¹. A likelihood ratio test statistic² suggested by Hamilton (1994) and Enders (1995), which follows a χ^2 distribution, was used to test the lower order restrictions of the seventh-order VAR. The estimated VAR models then served as the alternative hypothesis for testing Granger causality (Granger 1969, Sims 1972) among wildland fire activity, ENSO, timber harvest, and urban population density. The Granger causality tests determine whether a restriction of excluding a variable in the VAR model is binding at a given significance level. The test statistic for Granger causality is similar to that for determining lag length as stated earlier. To examine the causation within different scopes of interactions among wildland fire activity, ENSO, timber harvest, and urban population density, bivariate and trivariate VARs were also estimated and used for testing causality relationships using the same approach for the quadrivariate VARs. Finally, the impulse response functions of wildland fire activity to ENSO (MEI) were derived from the estimated quadrivariate VAR models. The Choleski decomposition method (Ender 1995) was used in identifying the impulse response functions.

¹ There are 29 coefficients in each equation of the seventh-order quadrivariate VAR and 33 (40-7) usable observations.

² $(T - c)(\log|\Sigma_r| - \log|\Sigma_u|)$, where T is the number of usable observations, c is the number of parameters estimated in each equation of the unrestricted system, and $|\Sigma_r|$ and $|\Sigma_u|$ are the determinants of the variance/covariance matrices of the restricted and unrestricted systems, respectively.

RESULTS

Causality relationships

The results of Granger causality tests are presented in Table 1. The tests based on the bivariate VARs indicate that only urban population density Granger-causes the number of wildland fires. In addition, area burned Granger-causes urban population density, suggesting that wildfire risks have influenced decisions on urban sprawl. Urban population density was found to Granger-cause timber harvest and MEI; timber harvest Granger-causes MEI. While the effect of urban sprawl on timber harvest is straightforward because the conversion of forestland to urban uses may increase timber harvest in the short run and decrease it in the long run, there is no known evidence about the effect of urban sprawl and timber harvest on ENSO events. Their impacts may be due to the forward-looking behavior in urbanization and timber harvest with respect to expectations about future ENSO events.

The causality test results based on the trivariate VARs show that more factors have contributed to wildland fire activity. MEI, timber harvest, and urban population density were all found to Granger-cause the number of wildland fires, which in turn Granger-causes MEI, timber harvest, and urban population density. Similarly, MEI, timber harvest, and urban population density Granger-cause area burned while there is no statistical evidence about the effect of the latter on the formers. These results demonstrate more comprehensive and complex causality relationships among the variables considered, and many of these causality relationships cannot be explained by those derived from the bivariate VARs. This implies that a factor/variable alone may not contribute to wildland fire activity, but when it is coupled with other factors it can significantly affect fire activity due to their interactions and joint effects.

The interrelationships among the four variables can be further explained by the causality test results based on the quadrivariate VARs. The number of wildland fires, timber harvest, urban population, and MEI are highly interrelated. The number of wildland fires Granger-causes

Table 1. Granger causality tests based on multivariate VARs.

Variable	Variable(s) Granger-caused by the variable in the first column	Lag	Number of wildfires		Area burned	
			χ^2 -statistic	Sig. [†]	χ^2 -statistic	Sig.
Bivariate VARs						
H	NF or A	1	1.520	0.218	0.006	0.938
NF or A	H		0.633	0.426	0.837	0.360
UPD	NF or A	2	9.506	0.002	1.543	0.214
NF or A	UPD		1.211	0.271	4.242	0.039
MEI	NF or A	1	1.968	0.160	0.665	0.415
NF or A	MEI		0.062	0.804	0.049	0.824
H	UPD	2	1.473	0.225		
UPD	H		6.197	0.013		
H	MEI	1	3.673	0.055		
MEI	H		1.381	0.240		
UPD	MEI	2	16.630	<0.001		
MEI	UPD		1.368	0.242		
Trivariate VARs						
H	MEI and NF or A	1	4.750	0.093	4.289	0.117
MEI	H and NF or A		2.505	0.286	2.983	0.225
NF or A	H and MEI		1.420	0.492	0.530	0.767
UPD	MEI and NF or A	1	8.661	0.013	9.801	0.007
MEI	UPD and NF or A		6.046	0.049	8.069	0.018
NF or A	UPD and MEI		20.614	<0.001	1.025	0.599
H	UPD and NF or A	1	4.633	0.098	13.421	0.001
UPD	H and NF or A		11.560	0.003	0.525	0.769
NF or A	H and UPD		11.117	0.004	3.419	0.181
Quadrivariate VARs						
H	UPD, MEI and NF or A	1	10.831	0.013	16.812	0.001
UPD	H, MEI and NF or A		13.348	0.004	5.620	0.132
MEI	H, UPD and NF or A		5.899	0.117	7.986	0.046
NF or A	H, UPD and MEI		9.439	0.024	0.520	0.914

[†]Probability of χ^2 distribution greater than the test statistic. The bold numbers indicate that the null hypothesis that the variable in the first column does not Granger-cause the variable(s) in the second column is rejected at the conventional significance level. The degrees of freedom (df), the number of restrictions, is 1, 2, and 3 for the bivariate, trivariate, and

quadrivariate VARs, respectively. Timber harvest, urban population density, and MEI. Timber harvest Granger-causes wildland fires, urban population density, and MEI. Urban population density also Granger-causes wildland fires, timber harvest, and MEI. But, MEI does not Granger-cause the number of wildland fires, timber harvest, and urban population density at the conventional significance levels. This indicates that the number of wildland fires is more significantly affected by timber harvest and urban sprawl than by ENSO events. However, the Granger causality tests based on the second set of the quadrivariate VARs suggest that MEI Granger-causes area burned, timber harvest, and urban population density. This implies that ENSO events contribute significantly to area burned. Overall, timber harvest and urban sprawl affect the number of wildland fires more significantly than ENSO events while ENSO events influence area burned more significantly than timber harvest and urban sprawl. Such results are not surprising. Historical data show that most wildland fires in the U.S. were caused by human or human activities while the largest portion of area burned was due to natural factors such as lightning (Sharpe et al. 1995).

The causality tests based on both sets of quadrivariate VARs indicate that timber harvest Granger-causes wildland fire activity, urban population density, and MEI. Two possible types of interrelationships among them may exist. One type represents the impact of timber harvest on wildland fire activity, urban sprawl, and ENSO. The other suggests the potential forward-looking behavior in timber harvest with the consideration of expected wildland fires, urban sprawls, and ENSO events. The similar argument can also be applied to the explanation of the causality relationship between urban population density and other variables in the VAR model associated with the number of wildland fires. While urban sprawl can affect the number of wildland fires, timber harvest, and ENSO, the causality relationship may also be explained by forward-looking behavior in urbanization in response to anticipated wildland fire risks and ENSO episodes.

Impulse response to ENSO

The impulse responses of wildland fire activity, area burned, timber harvest, and urban population density to MEI are shown in Figure 1. For a unit increase in MEI, the number of wildland fires would fall by about 4.5% from the mean in the same year and continue to decline in the following year to 8% below the mean before bouncing back and converging to the original path. In terms of area burned, a unit increase in MEI would cause area burned to drop by 4.7% in the first year with a slight recovery in the second year and increase by 2.5% above the mean in the third year before gradually returning to the mean. The impulse response functions show that an ENSO event (an increase in MEI) would decrease the number of wildland fires and reduce area burned initially, followed by increased area burned in the third year and afterwards before the impact fades out. Hence, the impact of ENSO events on area burned is not one-directional. This is because weather changes resulting from an ENSO event would affect vegetation dynamics and alter fuel patterns for many years to come. While area burned decreases with the decline in the number of fires at the beginning, as the number of fires tends to return to its original path, the disturbances in fuel patterns caused by an ENSO event may lead to larger areas to be burned when fires are ignited. The impulse response functions also indicate that an ENSO event would have long-lasting impacts on the number of wildland fires and area burned. While the most significant impact would occur during the first few years, its impact would take two decades to die out. Contrary to an El Niño event, a La Niña event would cause more fires, as well as more area burned initially.

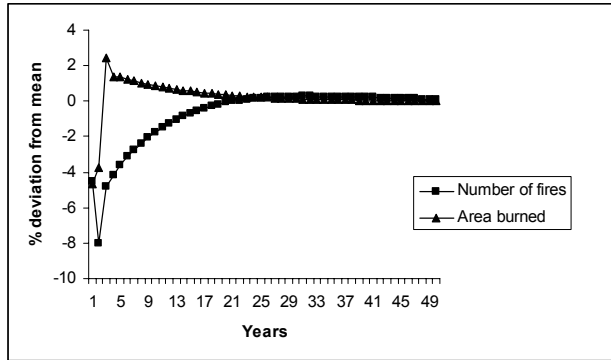


Figure 1. Impulse responses to ENSO anomalies (MEI).

CONCLUSIONS

This article investigates the causality of wildland fire activity. The VAR approach allows us to examine the causality relationships among wildland fire activity, timber harvest, urban sprawl, and ENSO without presumably excluding the potential feedback impact between them. Our results provide additional insights into the links among wildland fires, timber harvest, urban sprawl, and ENSO. There exist strong causality relationships among them, and their interrelationships are complex. An individual factor, which alone may not significantly contribute to wildland fires, can trigger wildland fire activity when coupled with other factors. ENSO, timber harvest, and urban sprawl all contribute to wildland fire activity in one way or another when they are considered jointly and simultaneously. The number of wildland fires seems to be more significantly influenced by timber harvest and urban sprawl than by ENSO while area burned is more likely to be affected by ENSO than by timber harvest and urban sprawl. Moreover, an ENSO event has long-lasting impacts on wildland fire activity. Its impact can last two decades before completely fading out.

Such complex relationships demonstrate the difficulty in developing and implementing wildland fire prevention and management strategies and policy. This also highlights the essential importance of incorporating timber harvest, urban development, and climate change in wildland fire policy formulation and implementation in a systematic manner. Accurate forecasts of ENSO events, which could precipitate wildland fire activity, would have values in preventing wildland fires or alleviating their damages. Effective wildland fire management plans should also address the lagged impact of ENSO episodes, particularly because ENSO anomalies could increase wildfire activity later while suppressing wildfire activity initially.

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A Predictive Model of Wildland Arson Ignitions

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Abstract: Arsonists ignite 1,500 wildfires that burn 50,000 acres annually in Florida, creating risks for residents and requiring substantial wildfire suppression capabilities, even in developed regions of the state. Using panel and non-panel versions of a Poisson autoregressive model of order p , or PAR(p) model, we identify the statistical influences of weather, systematic daily and monthly crime variations, wildland fuels management, recent wildfire activity, and aggregate economic factors on the count of daily wildland arson ignitions in nine high-arson counties over the period 1994-2001. We find that wildland arson demonstrates a high degree of persistence, likely accounting for either serial or copycat criminal activity or omitted factors correlated with recent ignitions. The highly autoregressive nature of arson on the daily time scale that we identified statistically is evidence that PAR(p) models may be better able to explain low-frequency outbreak events than would traditional count models. Our model estimates also may enable more efficient mobilization of law enforcement activities in high risk months and days of the week and in periods of arson outbreaks, help to determine where to stage wildfire suppression and suppression resources before the fire season begins, and aid in understanding long run patterns and expected trends in arson ignitions in places undergoing significant demographic changes.

Estimating the Value of Fuels Treatment on Colorado's Front Range

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Abstract: Urban and Wildland-urban interface area residents of Larimer and Boulder counties in Northern Colorado were surveyed using a dichotomous choice contingent valuation approach in order to compare the willingness-to-pay (WTP) for fuels treatment programs of counties with different demographic attributes and the WTP of different geographical groups within each county. This paper reports preliminary analysis of the data, with a more detailed analysis to follow in the near future. Initial Komolgorov-Smirnov goodness-of-fit analysis indicates that the distribution of positive responses is not significantly different for urban and WUI residents, nor is it different for Larimer and Boulder county residents.

INTRODUCTION

Colorado's Front Range has been classified as one of the nation's most critical wildland-urban interface (WUI) situations. This area is at high risk for severe wildfire with the possibility of substantial property and resource damage as well as high human risks. In the last 10 years the population of Colorado has increased by more than 30 percent. Eighty percent of that growth has occurred along the Front Range, where many people are moving into interface areas. There is also much concern regarding the financial and economic viability of treating fuels along the Front Range, as timber is of small diameter, growing cycles are long and commercial values are low. This research is a contingent valuation (CVM) study of the willingness-to-pay (WTP) for various fuels treatments by residents of the Front Range. Fire management activities and costs are currently relevant topics of discussion and to our knowledge no contingent valuation study has been done on this topic in this geographic area, nor have any been done that compare WTP values of urban residents and interface residents. This study will compare the willingness-to-pay (WTP) for fuels treatment programs of residents of Larimer and Boulder counties. It will also compare the WTP for fuels treatment programs of urban residents and WUI residents. Specifically, we will compare the WTP for prescribed burning and thinning programs of residents within each of the counties (Urban versus WUI) and between counties (Urban versus Urban and WUI versus WUI).

Contingent valuation methodology (CVM) has commonly been used by economists to value natural resources within a recreational context, such as in the valuation of fishing sites, wilderness areas, and wildlife viewing. It has also been used in valuing risk reducing activities, as related to hazardous waste, transportation safety, and drinking water quality. Recently, with increased discussion of the costs and benefits of fire and fuels management programs, contingent valuation has been applied to determining the value of fuels treatment programs, which reduce the risks associated with wildfire. Wildland-urban interface residents of a Michigan county that had been affected by fire were found to be willing to pay over \$57 per year for additional government investments in fire protection (Winter and Fried 2001). In a Florida study that compared English and Spanish speakers, respondents were found to be willing to pay a mean of about \$185 per year for prescribed fire treatments and about \$161 per year for thinning treatments (Bair 2001). This research will provide some insight into differences between Urban

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and WUI residents in regards to valuation of fuels treatment programs and will also show how varying regional demographics may affect valuation.

METHODOLOGY

Study Area/ Sample Population

The study area is comprised of residents of Larimer and Boulder counties in Northern Colorado (Figure 1). Both counties are located along the foothills of the Rocky Mountains, commonly known as the Front Range, and are adjacent to each other. Within each of the counties, surveys were sent to two different groups of residents, those living in urban areas and those living in the wildland-urban interface (WUI). Larimer and Boulder counties were chosen because of specific similarities and differences between the two. Both counties have similar population sizes (Larimer with 259,472 and Boulder with 297,686), have significant urban and interface areas, and have been affected by wildfires in recent years. On the other hand, the counties have different average incomes (Larimer \$48,655 and Boulder \$55,861), and possibly different attitudes towards forest management activities, including thinning and/or prescribed burning.

The Survey

We designed the survey as a dichotomous choice contingent valuation mail instrument. Questionnaires were sent out to a total of 3200 randomly chosen people: 1600 in Larimer County (800 Urban, 800 WUI) and 1600 in Boulder County (800 Urban, 800 WUI). The questionnaire included definitions of fire related terms; a description of possible impacts of fire, ranging from loss of structures to smoky air; and a simple description of current forest conditions. The questionnaire then asked some general questions, including the respondents' knowledge of and feelings towards thinning and prescribed burning, and whether or not they had ever been affected by fire. A description of a prescribed burning program was given and the valuation question asked. A description of a thinning program was given and a valuation question asked. Respondents were given a scenario of a hypothetical referendum; after a description of the specific program respondents were asked if this program were on the next ballot would they vote for or against it at the given price. Each questionnaire was sent out with one of 13 bid prices, ranging from \$12/year to \$1000/year. Each respondent received a questionnaire with the same bid price for each treatment. If the respondent noted that they would vote against the program a list of reasons was supplied and the respondent was asked to indicate their most important reason. The payment vehicle indicated for each treatment was an increase in property tax. The questionnaire ended with demographic questions, including household income, level of education, etc. (Note: Of all surveys returned, only a small percentage of respondents indicated that they did not own their residence.)

Hypotheses

- Interface residents will have a higher mean willingness-to-pay (WTP) than urban area residents for each of the treatments.
- WTP for each of the treatments will be different for residents of Larimer and Boulder counties.
- WTP for prescribed burning treatments will be different than for thinning treatments

RESULTS

Response Rates

The overall response rate, including Urban and WUI areas of both counties was a little greater than 30%. Specific group result rates were as follows:

Larimer County

Urban 27% WUI 41%

Boulder County

Urban 24% WUI 36%

It is not surprising to see that response rates in WUI areas are higher than those of Urban areas, due to the fact that residents of WUI areas have more at risk from wildfire than Urban residents do. The overall response rate of 30% is not unusual in random survey work; other studies have commonly found return rates to be about 30%. We also obtained responses from a sample of the non-respondents through additional mailings and found their responses to be no different than those of the original sample.

Respondent attitudes, perceived risk from forest fire and fire protection behavior

	Larimer County Urban	Larimer County WUI	Boulder County Urban	Boulder County WUI
Affected by Fire	36%	71%	42%	68%
Prescribed Burning Beneficial	88% Yes	87% Yes	90% Yes	80% Yes
Thinning Beneficial	84% Yes	90% Yes	86% Yes	87% Yes
High Risk	5%	31%	10%	52%
Medium Risk	15%	38%	16%	34%
Low Risk	39%	28%	46%	12%
No Risk	40%	3%	27%	3%
Defensible Space	17% Yes	74% Yes	17% Yes	78% Yes

The category 'Affected by Fire' includes impacts ranging from a personal structure being burned to visual impairment to a feeling of unease due to fire.

Gender and annual income characteristics of respondents

	Larimer County Urban	Larimer County WUI	Boulder County Urban	Boulder County WUI
Gender	66% M 28%F	61% M 33% F	64% M 35% F	67% M 28%F
<\$20,000	8%	6%	5%	4%
\$20,000–\$29,999	10%	9%	3%	8%
\$30,000–\$39,999	11%	12%	9%	8%
\$40,000–\$49,999	11%	12%	11%	12%
\$50,000–\$59,999	8%	14%	8%	9%
\$60,000–\$79,000	16%	14%	15%	15%
\$80,000–\$99,999	11%	10%	14%	6%
\$100,000–\$150,000	10%	4%	18%	16%
>\$150,000	5%	6%	8%	6%

Komolgorov-Smirnov Analysis

The Kolmogorov-Smirnov test is a goodness of fit test, similar to a chi-square test; however it is better suited for categorical data, such as the number of YES responses in each of the thirteen bid price categories of this study. The Komolgorov-Smirnov test is a more powerful version of the chi-square test, especially when the sample size is small or when frequency values are small. It is a test of the goodness of fit of an observed to an expected cumulative frequency distribution. In this case we paired the observed cumulative frequency distribution of YES responses for one sample group with that of another sample group (e.g. Larimer county Urban and Boulder county Urban) to test for statistical differences in the two distributions. This was done separately for pairings under the prescribed burning treatment and the thinning treatment.

Once the observed frequencies for each group are recorded, the cumulative frequencies are calculated and the equation $|d| = |(\text{cum. freq. (group 1)} - \text{cum. freq. (group2)})|$ is calculated for each class of data (each of the 13 bid prices). The Komolgorov-Smirnov test looks for the maximum absolute difference between any set of cumulative distribution function curves (of the number of YES responses). The largest difference (largest d) over all classes is divided by the sample size (n) and this is the calculated test statistic for the Komolgorov-Smirnov test, also called the D statistic. When the calculated D is greater than the critical D , the null hypothesis is rejected. The critical D value is determined based on sample sizes of the pairs and the confidence level chosen.

In this study, there is no singular critical D statistic; here, the D statistic varies for each pair of sample groups since the sample size of each group is different. For example, the number of Larimer Urban YES responses (prescribed burning) was 30 and the number of Boulder Urban YES responses (prescribed burning) was 40. The resulting critical D statistic was determined to be 0.294. As seen in the table below, the calculated D statistic for this pair was 0.133. The calculated statistic is less than the critical statistic; therefore there is no difference in the distribution of YES responses between these two groups. The complete results of the Komolgorov-Smirnov tests for each treatment are as follows:

Prescribed Burning Program

	Larimer Urban	Boulder WUI
Larimer WUI	0.110	0.096
Boulder Urban	0.133	0.119

Note: None of the calculated K_S values are significant

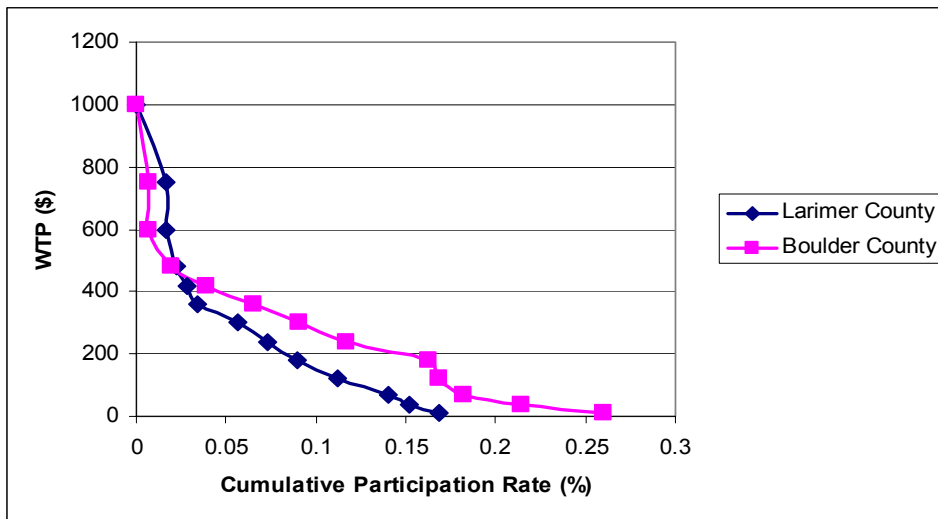
Thinning Treatment

	Larimer Urban	Boulder WUI
Larimer WUI	0.184	0.065
Boulder Urban	0.126	0.158

Note: None of the calculated K_S values are significant

Demand Curves

Using the participation rate (the percent of YES responses) at each bid price it is possible to create a demand curve for each sample group for the prescribed burning and thinning treatments. The following graph shows an example of the demand curves that could be estimated with the collected data, using Larimer county Urban and Boulder county Urban respondent data for a prescribed burning program:



The lowest square and diamond on the graph are the cumulative participation rates at \$12.

Reasons Against Treatment Programs

The reasons that respondents said NO, they would not vote in favor of a program were noted and calculated on a percentage basis. The following chart indicates the percentage of NO responses of Larimer Urban and Larimer WUI respondents for each of the given reasons for the prescribed burning program:

Reasons Against (Prescribed Burn Program)		
	<u>L Urban</u>	<u>L WUI</u>
	(17% Y)	(32% Y)
Too expensive	45%	51%
Only at no cost	18%	18%
Only WUI residents pay	27%	10%
Wouldn't work	5%	7%
Opposed	8%	15%
Defensible space	5%	24%
Other	8%	15%

Included in the Other category were reasons such as: 1) my taxes are already too high, or 2) I need more information to decide. The total percentages for each group are greater than 100 due to some respondents choosing more than one reason. It is interesting to note that 10% of the WUI respondents were not in favor of a prescribed burning program at a certain price because they thought that only WUI residents should pay.

CONCLUSIONS

- Distribution of YES responses of urban residents are not significantly different than WUI residents
- Distribution of YES responses of Larimer county residents are not significantly different than Boulder county residents

Additional demand curves could be estimated comparing Larimer WUI and Boulder WUI respondents, Larimer Urban and Larimer WUI respondents, and Boulder Urban and Boulder WUI respondents. The same could also be done for the thinning program. These demand curves would show the cumulative participation levels at each of the bid prices.

Although the study was designed as a comparison between Urban and WUI residents and between Larimer and Boulder counties, if further analysis shows that the WTP responses of the various groups are no different, it will be possible to combine the data into one large data set and determine a value for fuels treatment programs for the Northern Colorado area. This would be valuable in that the number of respondents in the data set would be quite large and values for fuels treatment programs would still be able to be calculated for this area.

The results presented at the conference and in this paper are preliminary results only. An in-depth analysis and discussion of the data will be forthcoming. Currently we are in the process of using logistic regression to determine the mean WTP for each of the treatments by residents of each of the sample groups and to determine the factors that are important in deciding whether or not to participate in the market. We will also determine if the WTP for prescribed burning treatments differs from the WTP for thinning treatments and take a look at protest response rates.

ACKNOWLEDGEMENT

Authors have benefited from comments and suggestions made by Dr. Robin Reich, Department of Forest, Rangeland and Watershed Stewardship at Colorado State University. Fort Collins, CO.

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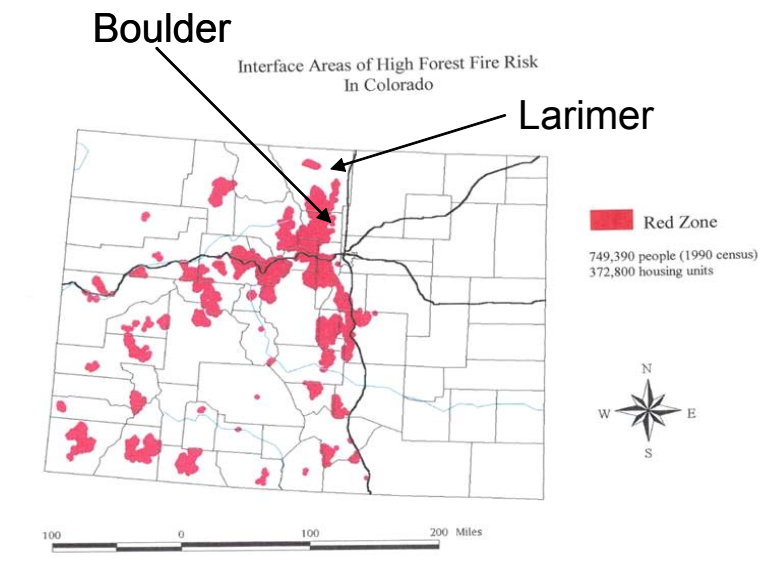


Figure 1. Map of Colorado, with Larimer and Boulder counties indicated. This map is also Colorado's Red Zone map, which indicates areas at high risk if wildfire. Currently, over one million people live in the Red Zone of Colorado.

Florida Ranchers' Willingness to Adopt Silvopasture Practices: A Dichotomous Choice Contingent Valuation Approach

Ram K. Shrestha¹ and Janaki R.R. Alavalapati

Abstract: Silvopasture is considered as an environmentally benign land use system relative to conventional cattle ranching. However, most of the environmental benefits of silvopasture are external while the costs are internal to ranchers providing ranchers little or no motivation to implement silvopasture practices. We assessed Florida ranchers' willingness to adopt silvopasture practices using a dichotomous choice contingent valuation method. The results suggest that ranchers will adopt silvopasture practices for a premium price of \$0.15 /lb. of beef or a direct payment of \$9.32 /acre/year. We estimate that the total annual payments required for the adoption of silvopasture practices in Florida would be \$56.45 - \$72.43 million.

Key Words: stated preference; public good; pollution runoff; silvopasture; watershed

INTRODUCTION

Silvopasture, an agroforestry technology that combines forages and livestock with trees, has been shown to effectively address pollution runoff problems and provide various environmental benefits such as water quality improvement, soil conservation, carbon sequestration, wildlife habitat protection, and aesthetics (Alavalapati and Nair, 2001; Clason and Sharrow, 2000; Kurtz, 2000; EPA, 1995). Specifically, trees and other vegetation help filter surface runoff and absorb surplus nutrients before they reach streams and lakes (EPA, 1995; FAC, 1999; Clason and Sharrow, 2000). Added tree cover in silvopasture will also sequester atmospheric carbon dioxide and thus can provide carbon credits under the Kyoto Protocol (Sedjo, 2001; Cannell, 1999). Ranchlands provide habitat for wildlife including many threatened and endangered species (Morrison and Humphrey, 2001; Benson, 2001), and this service can be further enhanced through silvopasture. For these reasons, silvopasture is often commended by agricultural scientists and professionals as an environmentally benign land use.

Most of the environmental services associated with silvopasture are external to cattle ranchers' production decisions. Furthermore, adopting silvopasture will cost ranchers more in terms of costs associated with management, learning silvopasture practices, and reduced cattle output as more trees leads to less forage production. While some of these costs may be partially offset by timber revenues and an increase in hunting revenues due to silvopasture, these benefits are neither certain nor full recompense. Therefore, cattle ranchers have little or no motivation to adopt silvopasture unless incentives are provided to internalize these external benefits.

Literature suggests that producers of environmental goods and services can be encouraged to supply them at optimum level through incentive mechanisms (Cooper and Keim, 1996; Kingsbury and Boggess, 1999; Purvis et al., 1989). Various federal and state programs such as Conservation Compliance, Sodbuster, Swampbuster, and the Conservation Reserve Program (CRP) in the U.S. are designed to encourage conservation practices on farmlands (Feather et al., 1999; Ribaud et al., 1999; Heimlich, 1998; Westcott et al., 2002). Many conservation practices such as filter strips, riparian buffers, shelter belts, windbreaks, and grass waterways, which are structurally and functionally similar to silvopasture, qualify for incentives

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under these programs. Financial incentives to cattle ranchers reflecting these same environmental benefits through silvopasture are therefore justified as well.

Cattle ranchers' willingness to adopt silvopasture practice and accept minimum incentive payment for its implementation can be estimated using the contingent valuation methods (CVM) that are used to evaluate farmers' willingness to participate in other conservation programs in the U.S. (e.g., [Cooper and Keim, 1996](#); [Kingsbury and Boggess, 1999](#); [Lant, 1991](#); [Purvis et al., 1989](#)). [Cooper and Keim \(1996\)](#) studied farmers' willingness to adopt water quality protection practices with incentive payments, which addressed integrated pest management, legume crediting, manure testing, nitrogen applications, and soil moisture testing. The authors conducted CVM surveys in four watershed areas i.e., Eastern Iowa and Illinois Basin areas, the Albemarle-Pamlico Drainage area of Virginia and North Carolina, the Georgia-Florida Coastal Plain, and the Upper Snake River Basin area. Similarly, [Kingsbury and Boggess \(1999\)](#) used the willingness to accept (WTA) elicitation approach of contingent valuation method to study riparian landowners' willingness to participate in conservation reserve enhancement program in Oregon. To our knowledge, this is the first study attempting to analyze cattle ranchers' willingness to adopt silvopasture and elicit their WTA for such practices.

Florida was selected for this study because of its high potential for silvopasture practices. The state contains approximately 6 million acres of ranchland supporting nearly 2 million cows and calves ([FCA, 1999](#); [FAS, 2002](#)). It ranks the 10th in the U.S. and the 3rd in states east of the Mississippi River for beef cattle herd size ([Wade et al. 2001](#)). We employ a dichotomous choice (DC) elicitation approach to estimate ranchers' WTA for silvopasture adoption. Two incentive mechanisms are used as the payment modes: a premium on beef price and a direct payment on per acre basis. There are several reasons for the choice of these two payment options. First, ranchers may prefer one option over another for various reasons. For example, farmers often prefer price premium policies to direct payments so that they are not perceived as welfare recipients. Second, government agencies prefer one policy over the other for economic efficiency and administrative reasons ([Babcock and Schmitz, 1996](#); [Helmberger, 1991](#)). Finally, this approach will assist us in identifying the least cost policy option.

Methodology and Research Design

We used dichotomous choice CVM to elicit cattle ranchers' minimum willingness to accept incentive payments as the measure of their willingness to adopt silvopasture practices. In dichotomous choice CVM, respondents are asked to provide only a 'yes' or 'no' response to a randomly assigned dollar bid as the value of the desired change in the quantity or quality of a certain environmental good. Thus, dichotomous choice CVM modeling accounts for the probability that the respondent's minimum WTA is less than or equal to the offered incentive payment. This approach is considered more incentive compatible, and is often preferred in eliciting values of non-market goods such as environmental benefits ([Arrow et al., 1993](#); [Mitchell and Carson, 1989](#)).

Dichotomous Choice Method

Ranchers' decision making process to adopt or not adopt silvopasture practices on their ranchland can be viewed as the utility maximizing behavior of households (Lohr and Park, 1994; Cooper and Keim, 1996). Although the variables entering into ranchers' utility function are often unobservable and utility functions are unknown to the researcher, they can be viewed as a function of deterministic and random components (McFadden, 1974) as,

$$V_{ij} = v_{ij} + \varepsilon_{ij} \quad (1)$$

where V_{ij} is the conditional indirect utility of individual rancher i from alternative land uses j , v_{ij} is the deterministic component of the model, and ε_{ij} is the random component. In this regard, selection of silvopasture over conventional ranching implies that the utility of v_{i1} is equal to or greater than that of v_{i0} , where $j = 0, 1$ representing conventional ranching and silvopasture, respectively. Thus,

$$v_{i1}(y + c; x) + \varepsilon_{i1} \geq v_{i0}(y; x) + \varepsilon_{i0} \quad (2)$$

where, y is rancher i 's income, c is the incentive payment, and vector x is socioeconomic attributes of the rancher which affect their adoption decision. Variable c can be interpreted as $c^* + \delta$, where δ is the pecuniary cost of conventional ranching minus the pecuniary cost of silvopasture practices, and c^* is required incentive payment (Cooper and Keim, 1996). Thus, c can be considered as a "net" incentive payment. Let,

$$v_{ij}(y; x) = \gamma_j + \alpha y, \quad (3)$$

where $\alpha > 0$, and $\gamma = x'\beta$, where β is vector of estimated coefficients. Then, the rancher is willing to accept c if

$$\gamma_1 + \alpha(y + c) + \varepsilon_{i1} \geq \gamma_0 + \alpha y + \varepsilon_{i0} \quad (4)$$

Overall, the utility is random suggesting that the researcher can only analyze the probability of ranchers' choice of an alternative over another. The probability of rancher i choosing alternative j , $p(\cdot)$, or the rancher's willingness to accept the incentive offer for his/her adoption of silvopasture practices may be expressed as

$$p_{ij}\{c \geq WTA\} = p\{v_{i1}(y + c; x) + \varepsilon_{i1} \geq v_{i0}(y; x) + \varepsilon_{i0}\}, \quad (5)$$

where WTA is the minimum incentive payment c required by ranchers to change from conventional ranching to silvopasture. Therefore, if the difference between these two utility functions is positive, the rancher will adopt silvopasture practice upon receiving this incentive. This utility difference model can be expressed as,

$$\Delta v = v_{i1} - v_{i0} = \gamma + \alpha c \quad (6)$$

where $\gamma = \gamma_1 - \gamma_0$. Assuming the error terms of the utility function are independent and identically distributed (iid) and follow logistic distribution, the choice probabilities can be estimated using logit specification (Kingsbury and Boggess, 1999; Lohr and Park, 1994; Maddala, 1999). The logistic distribution used to model the probability of adoption may be expressed as,

$$p(j = 1 | x, c) = [1 + e^{-\Delta v}]^{-1} = [1 + e^{-(x'\beta + \alpha c)}]^{-1} \quad (7)$$

where the logistic model is specified as the probability of 'yes' response to silvopasture adoption if the incentive offer is price support per pound of beef produced or direct payment per acre enrolled.

In addition to analyzing explanatory variables influencing ranchers' adoption decision, we can estimate WTA as the welfare measure using the utility difference model. We estimate mean WTA using the predicted value of the WTA function estimated at the mean value of the covariates (Cameron, 1988; Syamsunder and Kramer, 1996).

Survey Design and Implementation

The dichotomous choice survey includes three main sections: introduction and description of the good, valuation scenario and elicitation questions, and socioeconomic information questions. To introduce the survey, we explained its objective and confirmed that this survey will not track confidential information. Then, the respondents were asked to provide information on the natural attributes of their ranch including forest cover, ranch size, location, cattle population, and land uses. We then presented a concise description of the proposed change in current land use to silvopasture, and described its benefits and costs. Based on the feedback from pre-tests the term 'tree-cattle' pasture was used throughout survey to represent silvopasture systems. In particular, the proposed changes included 20% pastureland with forest or brush cover, 60 ft. streams and 12 ft. grass buffer strips, and restoration of wetlands, as applicable. Valuation questions followed the scenario description. To analyze ranchers' preferred incentive policies i.e., price support or direct payment and to compare the costs of these incentive policies, we presented two valuation questions in a sequence. Finally, some demographics, household income, and occupation questions were presented.

Information from focus group meetings and pre-testing was used to revise the questionnaire. Survey respondents were drawn from the Florida Cattlemen Association (FCA) membership directory. Prior to the survey we published a brief informational article in the FAC magazine about the upcoming survey. Information about FCA membership is confidential, so we were unable to obtain the entire member lists. The FCA provided us with assistance in sample selection and mailings. A sample of 1,000 respondents was drawn randomly from member lists, and the survey packet with a questionnaire and cover letter was mailed to each respondent in the first week of May, 2002. Three weeks after the first mailing, we sent reminder letter with another copy of survey to recipients who had not responded. After first mailing, we received a number of phone calls and email responses from respondents indicating that they were not ranchers although they had membership in the FCA. The FCA indicated that allied members or members without cattle ranches would account for about 10% of the total members. This resulted in reducing effective sample size to 900. After the second mailing, we received a total of 421 survey responses resulting a response rate of 47% in our survey.

Respondent Characteristics and Empirical Model

More than half of the ranchers' responses to the questions about their willingness to adopt silvopasture practices indicated that they would accept the offered amount regardless of the payment method. On average, ranchers accepted the payment offer 59.08% of the times when it was price support and 51.18% of the times when it was direct payment. A slightly higher acceptance of price support may have some policy consequences when comes to actual payment offer.

Descriptive analyses of the survey responses indicate that cattle ranches in Florida are fairly close to towns and consist of several natural attributes already providing various use and non-use values. The survey responses indicate that, on average, ranches are within 16.75 miles from a major town. Typical ranchers noticed nearly 5 species of important birds or animals occur in their ranches with a maximum of 19. About 40 – 50% ranchers reported that some form of marsh or wetland, creek/stream, and some hardwood trees exist on their ranches. Thirty percent of the ranchers indicated that there is longleaf pine on their ranch. More than half of the ranches have improved pasture, a concern to the Florida Department of Environmental Protection because it tends to generate more pollution runoff. Hunting, fishing, and horseback riding are noted as popular recreation activities on many ranches. In particular, about 60 percent of ranchers experienced some

level of commercial or family recreational uses of their ranchlands. About 10 percent of ranchers indicated that they have commercial hunting leases on their ranches. Hunting leases are relatively new on private ranchlands wherein ranchers sign a lease agreement with hunting clubs for a fixed term. Our survey indicates that Florida ranchers receive average revenue of \$6.30 /acre/year from hunting leases. Survey results show that a typical ranch size is 1,500 acres with nearly 300 cattle. Ranchers' mean household income is about \$74,000. The results indicate that an average rancher is over 50 years old with nearly 15 years of formal education and about 31 years of ranching experience. One-in-ten ranchers are associated with some environmental organizations.

We anticipate that natural attributes of a ranch would positively influence ranchers' silvopasture adoption or willingness to accept the incentive offer. However, if the ranch is predominantly under improved pasture, changing to silvopasture would cause the rancher to forego more forage benefits of the pasture. Thus, we expect that improved pasture would have negative influence on the likelihood of ranchers' adoption (Table 1). Recreation use of ranchland depends on the natural attributes of the land including vegetation. If ranchers are receiving recreation benefits, they would be more likely to participate in silvopasture practices. As such, it is likely that hunting, fishing, and horseback riding variables will have a positive impact on rancher's adoption decision.

Socioeconomic variables included in the model are ranch size, cattle herd size, household income, and respondents' age, education, and affiliation with environmental organizations. We also use Florida Department of Environmental Protection regions: northern and central regional dummies, to account for regional variation in ranchers' adoption. Non-linearity in quantitative variables within the model is accounted for using quadratic terms for incentive payments, ranch size, and income variables.

Table 1: Definition of the variables included in the model

Variable	Expected Sign	Definition
ADOPT	--	Ranchers' participation, the dependent variable recording ranchers' Yes/No response to incentive offer
<i>Payment Offer and Opportunity Costs:</i>		
PAYMT	+	Price support per pound of beef or direct payment per acre in U.S. dollars
PAYMTS	\pm	Square of the payment offer
ACRE	\pm	Land area of the ranch
ACRES	\pm	Square of the land area of the ranch
NORTH	\pm	1 if the sample from northern Florida
CENTRAL	\pm	1 if the sample from central Florida
ACCESS	+	Access to the nearest city represented by the road distance in miles
<i>Natural Attributes:</i>		
WNUM	+	Number of wildlife species reported to occur in the ranch
CKST	+	1 if any creek or stream is found in the property
MARSH	+	1 if any marshy area exist in the property
FOREST	\pm	1 if any hardwood forest cover currently exist in the ranch
LLPINE	\pm	1 if the forest cover that currently exist in the ranch is the longleaf pine
IMPPAST	-	1 if ranch is primarily an improve pasture
<i>Recreation Benefits:</i>		
HUNT	+	1 if recreation hunting is currently allowed in the ranch
FISH	+	1 if recreation fishing is currently allowed in the ranch
HBACK	+	1 if horse back riding is currently allowed in the ranch
<i>Socioeconomic Characteristics:</i>		
INC	-	Household income in thousand U.S. dollars
INCS	\pm	Square of the household income
AGE	\pm	Age of the respondent
EDU	\pm	Education of the respondent in years spent in formal education
MEMB	+	1 if the respondent is a member of any environmental organization

MODEL RESULTS AND DISCUSSION

We estimated two econometric models to analyze rancher's willingness to adopt silvopasture practices. Signs and significance of the estimated coefficients suggest that results are consistent with *a priori* expectations. The variable representing incentive payment offer (*PAYMT*) is positive and highly significant in both models suggesting higher probability of adoption if the payment is higher, a result consistent with demand theory. The coefficients on quadratic terms of the incentive payment offer (*PAYMTS*) are negative and highly significant in both models, suggesting a non-linear relationship. We attempted linear specifications for both models first but the quadratic models outperformed the linear, thus we present quadratic results for our analysis (Table 2).¹

We included spatial variables representing ranch size, regional dummies, and access to the urban centers to incorporate the opportunity cost of alternative land uses in the model. We found only variable representing access to the urban center (*ACCESS*) as significant. The positive sign and significance of the coefficient of this variable in the direct payment model suggest that an increased distance from urban center corresponds with increased likelihood of ranchers adopting a silvopasture. This result is consistent with [Kingsbury and Boggess \(1999\)](#) who found lower opportunity cost of alternative land use increased the probability of farmers' participation in conservation programs.

¹ [Adamowicz et al. \(1998\)](#) found quadratic model outperforming the linear model in their stated preference data though both models produced qualitatively similar results.

Table 2: Logit models of ranchers' willingness to adopt silvopasture practices

Variable	Price Support		Direct Payment	
	Coefficient	Std Error	Coefficient	Std Error
<i>Payment Offer and Opportunity Costs:</i>				
PAYMT	5.2159**	1.7901	0.2934**	0.0992
PAYMTS	-4.9301**	2.0101	-0.0113**	0.0039
ACRE	-0.0001	0.0001	-1.83E-05	0.0001
ACRES	9.78E-07	1.22E-06	3.48E-07	1.05E-06
NORTH	0.2411	0.4042	-0.4486	0.3900
CENTRAL	-0.2053	0.3535	-0.3893	0.3415
ACCESS	0.0123	0.0082	0.0183**	0.0079
<i>Natural Attributes:</i>				
WNUM	0.1001**	0.0519	0.1459**	0.0513
CKST	-0.2502	0.2680	0.4553*	0.2631
MARSH	0.5935**	0.2886	-0.1990	0.2771
FOREST	-0.2420	0.2692	-0.4102	0.2652
LLPINE	0.6631**	0.2786	0.8586**	0.2680
IMPPAST	0.0024	0.0041	-0.0035	0.0040
<i>Recreation Benefits:</i>				
HUNT	0.6042**	0.2733	0.4164	0.2674
FISH	-0.1600	0.2701	-2.21E-01	0.2608
HBACK	-0.5439	0.4736	0.0219	0.4597
<i>Socioeconomic Characteristics:</i>				
INC	-0.0157	0.0107	-0.0230**	0.0095
INCS	0.0837	0.0660	0.0958*	0.0557
AGE	-0.0108	0.0080	-0.0091	0.0078
EDU	0.0467	0.0526	0.0438	0.0508
MEMB	-0.3484	0.3839	-0.2280	0.3824
CONSTANT	-1.2806	1.0485	-1.3255	1.0776
Log-L	-221.69		-231.47	
Chi-Square	52.03**		60.78**	
Correct prediction	64.45%		66.93%	
N	366		378	

* Coefficient significant at $p < 0.10$, ** Coefficient/statistics significant at $p < 0.05$

The results also indicate that the existence of natural attributes will increase adoption. The variables representing wildlife presence (*WNUM*) and existence of creeks and/or streams (*CKST*), marshlands (*MARSH*), and longleaf pines (*LLPINE*) have a positive impact on ranchers' adoption of silvopasture. These results suggest at least two interpretations. First, the presence of natural attributes on ranchlands would diminish the productive use of the land for other agricultural purposes, thereby incurring lower opportunity costs of land use changes, which leads to a greater likelihood of ranchers adopting silvopasture practices. Second, ranches with these attributes are better suited for multipurpose use of their ranchlands such as pasture and outdoor recreation. As hunting and other outdoor recreation uses by families, friends, and recreation clubs are being popular on these lands, we would expect that the presence of natural attributes will encourage ranchers to adopt silvopasture.

In addition, we accounted for the effect of recreational use of ranchlands in our analysis. The coefficient on the variable representing the presence of recreational hunting (*HUNT*) is positive and highly significant in the price support model, which suggests that ranchers are more likely to adopt silvopasture practices if they currently use their ranches for recreational hunting. However, this variable is significant only at $p < 0.12$ in direct payment model. Fishing and horseback riding are the other two variables representing recreation uses, but their coefficients are insignificant in both models.

To assess the influence of ranchers' economic and demographic factors in their adoption decision, we incorporated income, education, age, and their membership in environmental organizations in our analysis. We found, however, that only the coefficients on income and its quadratic form were significant in direct payment model. The negative sign on income variable (*INC*) suggests a lower likelihood of adoption from high income ranchers. The coefficients retain the same signs, but no longer significant if the incentive is a price support.

We estimated ranchers' mean WTA for their adoption of silvopasture practices. On average, a price premium of \$0.15 /lb. of beef or a direct payment of \$9.32 /acre/year is required by ranchers to adopt silvopasture practices.¹ The confidence interval of the mean WTA was estimated using Krinsky and Robb approach ([Park et al., 1991](#)). The 95% confidence interval estimates indicate the value of \$0.004 - \$0.283 and \$6.075 - \$9.955 for price support and direct payment policies, respectively.

Our estimates of ranchers' WTA for silvopasture practices is comparable with previous studies on farmers' willingness to participate in conservation programs in the U.S. (e.g. [Cooper and Keim, 1996](#); [Lohr and Park, 1994](#)). [Lant \(1991\)](#), for example, reported that average annual payment under Conservation Reserve Program was \$48.93 /acre at national average, while state average ranged from \$37.48 /acre in Montana to \$81.00 /acres in Iowa. The relatively lower WTA estimate in our study may be due to the complementary nature of cattle and tree farming systems. Unlike Conservation Reserve Programs where farmers face more restrictions, silvopasture requires only modest changes from current ranching practices.

Using the WTA estimates, we calculate the total annual incentive payments required for silvopasture adoption state-wide. The USDA 1997 Census of Agriculture shows that Florida has more than 6.06 million acres of pasture and ranchlands ([USDA, 1997](#)). Using annual direct payment of \$9.32 /acre, the total cost of this policy would be \$56.45 million. The 2002 Florida Agricultural Statistics Service indicates that Florida currently has nearly 2 million cattle resulting in annual sales of approximately 482.84 million pounds of beef ([FAS, 2002](#)). Using rancher WTA of \$0.15 /lb. of beef as price premium, the cost of a price premium policy would total \$72.43 million annually. Current cattle sales data show that annual cash receipts from cattle is \$360.52 million ([FAS, 2002](#)). Thus, roughly 20% reduction in cattle output in response to the 20% ranchland set aside under tree cover translates into the opportunity costs of \$72 million. This shows that our estimate of ranchers' WTA for their adoption of silvopasture land use is very close to the opportunity cost of silvopasture adoption.

CONCLUSION

Agroforestry research suggests that silvopasture is an environmentally benign land use practice relative to conventional cattle ranching. Silvopasture limits pollution runoff, sequesters

¹ While estimating mean WTA, the quadratic term in payment variable (*PAYMENTS*) is evaluated at the mean of the payment to make it consistent with re-parameterization of the coefficients on other explanatory variables ([Cameron, 1988](#)).

atmospheric carbon dioxide in the form of tree biomass, and improves wildlife habitat. These environmental benefits, however, are not exclusive to ranchers, yet the costs of silvopasture practices are internal to their production decisions. As a result, ranchers may not choose to adopt silvopasture voluntarily and the supply of environmental services will, therefore, remain sub-optimal. Providing economic incentives will enable ranchers to adopt silvopasture practices and generate environmental services.

Designing appropriate policy incentives to promote silvopasture requires information about the societal value of environmental services generated through silvopasture and the expected costs of their provision. If the benefits of environmental services are greater than their cost of production, we will have net social benefit, and compensating the cost of production will be justified. [Shrestha and Alavalapati \(2002\)](#) used choice experiment approach of stated preference method to estimate public willingness to pay for limiting pollution runoff, sequestering atmospheric carbon dioxide in the form of tree biomass, and improving wildlife habitat through silvopasture in the Lake Okeechobee Watershed of south-central Florida. Their results indicate that an average household would pay \$137.97 /year for five years to realize the additional environmental benefits associated with silvopasture practices on ranchlands. At the watershed level this amounts to approximately \$924.40 million, and at the state level it would be much higher. The results of our study show that Florida ranchers would adopt silvopasture if there is a \$0.15 /lb. premium price on beef or a direct payment of \$9.32 /acre/year. At the state level, this would cost Floridians \$72.43 and \$56.43 million, respectively. Estimates clearly indicate that households' willingness to pay for environmental services is higher than ranchers' willingness to accept for silvopasture adoption. This suggests that society would gain if policy incentives are designed to promote silvopasture.

The results of our study show the societal cost of pursuing a price premium policy is more expensive relative to a direct payment scheme. Furthermore, the price premium policy requires a labeling program to indicate that the beef is produced under silvopasture practices, which might result in additional transaction costs. A direct payment scheme on the other hand would be very similar to a conservation reserve program and can be implemented through existing government institutions. However, it is hard to predict long-run impacts of either price premium or direct payment policy on land use shifts. Increasing the profitability with these incentive schemes might stimulate ranchers to expand their operations and other landowners to switch to silvopasture. This might cause an expansion in the beef production, but a reduction in the beef price. In such a case, ranching or silvopasture can be less profitable and lands might be converted to other uses including urban development.

Acknowledgements: We thank John Loomis for his suggestions on model estimation and Cynthia Wilkerson for assisting us with survey development and administration. This research was made possible by the financial support from the USDA (Initiative for Future Agriculture and Food System) and the Florida Agricultural Experiment Station.

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Grazing Conservation Tillage Corn with Steers in an Agroforestry Environment: Advantages for Land Owners, Wildlife and Timber Producers.

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Abstract: A pilot project designed for the small landowner was conducted at the Leveck Animal Research Center from April through October, 2002, has shown that grazing conservation tillage corn with steers can be a very profitable venture. Gross returns per acre were \$290 with room for improvement. Direct costs per acre were \$120-\$140. There were no detectable negative effects on the steers due to this grazing system. No yellow fat (an undesirable product for consumers) was found and taste panel analysis of the resulting beef has found it to be highly acceptable with no off flavors or tenderness problems. This is a system that was designed for the small producer that has land that would normally not be considered arable due to erosion potential or is too small to justify expensive harvest equipment. The majority of the "hill" area in Mississippi fits this description.

Many other potential advantages were "discovered". First this system eliminates endophyte infected tall fescue without removing the land from production. It feeds cattle to finish or near finish condition without using any of the stored corn crop. It provides ideal habitat for turkeys, quail, rabbits, deer, mourning dove, raptors and other wildlife species. Mechanical harvesting of corn is efficient with little wastage or dropped grain for wildlife. This system has shown to have at least 10% wastage or 500-600 lbs of dropped corn per acre, 100 bu/acre yield. Since animal grazing is over an extended period, dropped grain is available for 3 to 4 months, the amount varying with the corn yield.

A more appealing thrust for this project would be to use this system in an agroforestry context. Doing so would have many advantages for both timber production and wildlife habitat and ultimately the landowner. Improvements to the land or trees, such as pruning, become deductible expenses. A dominant advantage to this system is that the landowner has a significant annual income from the land during timber establishment and early growth. The income, while quite high for the grazing alone, can be supplemented by fee hunting for upland game or deer and turkeys. This system has the potential to move turkey nesting sites from high predation bottomland locations to upland areas. The cropland component of this system provides a clean open area ideal for quail chick survival.

Most of the nutrients applied for corn production remain on site. Conservation tillage requires a fairly high level of N. The N not utilized by the animals will be left for the trees. This should accelerate growth of the pine trees and improve timber yields. This project will utilize two different age classes, 3 and 10-year-old trees at initiation to evaluate the effect of cattle feeding around young trees. Pruning of the trees is expected to produce better quality sawtimber than is usual in unthinned plantations. Economic returns, including tax analysis, will be compared to traditional forest plantation systems.

An Analysis Process Used to Stratify Timberland Management Compartments Within An Ownership Based on Long-Term Earning Potential

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Abstract: As part of an ongoing effort to increase efficiencies in all aspects of forestland ownership and management, an analysis was conducted as the first segment of a larger project to stratify the forestlands managed by Temple-Inland Forest Products Corporation into three distinct categories: Non-Contributory, Investment Grade and Higher and Better Use. The criteria of *site productivity*, *land use classification* and the *percentage of productive acres within a compartment* were incorporated into a model to define those lands that do not effectively maintain a sufficient economic earning potential, and can therefore be considered as non-contributory. A compartment is a collection of timber stands that are geographically arranged in such a manner as to constitute a logical management unit. Land expectation values (LEVs) representative of the type of management activities appropriate for each type of site were applied as the base earnings potential for each stand within a compartment. Compartments with a computed return below a requisite earnings threshold will be considered non-contributory from a timber growth perspective. These compartments will be prioritized for further examination by forest managers to verify data accuracy, evaluate alternative management options, and to incorporate factors not conducive to inclusion in an LEV-based analysis.

INTRODUCTION

Temple-Inland Inc. owns or has management rights to 2.1 million acres of forestland in four states: Texas, Louisiana, Georgia and Alabama. The acquisition history of this land dates back to 1893, when T.L.L. Temple purchased 7,000 acres of timberland in east Texas to supply a sawmill that he would build the following year (Baxter 2002). Landholdings steadily increased over the next 110 years to the present levels. The reason for acquiring more land was generally to support periodic increases in conversion capacity, whether that meant the building of a new sawmill, or the acquisition of a paper producing company. Most recently, a small amount of land has been sold.

Regardless of the advent of modern, intensive plantation management, industrial forestry has historically been an *extensive* affair. Although the productive capacity of an individual piece of ground to grow crop trees has and always will be an important factor in its acquisition decision, other factors have tended to be equally, if not more, important. These factors can generally be defined as availability, scale, and that old real estate adage – *location, location, location*. First, availability dictates what you can and can't buy, depending on how much you are willing to pay. Second, large-scale acquisitions invariably contain underperforming sub-elements, or parcels. The buyer may like the high quality land and timber comprising ninety percent of the offering, but must take the less desirable ten percent to get it, as the seller may not offer to exclude the lower quality portion from the purchase. As for location, that's obvious: a tract of land with only moderate productivity may still be a good buy if it is only a few miles from a mill, or contains an existing road network providing good access.

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So over time a large landbase develops that, in its entirety, fulfills the mission of providing a requisite portion of the sustainable supply of fiber to a set of converting mills. And historically, the extent of the purpose of owning forestland was one of insurance of supply, to provide a significant portion of the internal fiber demand to guarantee continuous supply in the face of any possible market disruptions. Perspectives have changed over time. Shareholders expect a reasonable return on investment from all elements of a corporation; insurance against supply disruptions is not sufficient. It can also be argued that southern fiber markets are now robust enough that significant supply disruptions are not very likely, as long as it is recognized that a short-term price premium may be unavoidable.

As the measure of effectiveness for a landbase has changed over time to one of generating an acceptable return on investment, it is invariably the case that within a landbase are individual tracts that, measured by themselves, cannot provide a sufficient economic return from the act of sustainable timber management. To ensure that the total forest asset is providing an acceptable economic return to the firm, as is required of all other assets of the firm, it is therefore necessary to periodically assess the performance potential of each individual portion of the forest.

OBJECTIVE

The goal of this project was to develop a quantitative process by which to assess all land holdings in Temple-Inland Forest for their applicability of providing an acceptable economic return from management for fiber production. Those lands identified as not currently generating an acceptable return are being further reviewed in more detail to confirm the initial assessment, or recognize the contributions the lands make to other objectives. Pending confirmation of the initial assessment, these lands will be identified as non-contributory, and appropriate action will be taken to either dispose of them in an optimal manner, or perhaps alter the manner in which they are currently managed in an attempt to increase their earnings potential to an acceptable level. Only forestland owned by Temple-Inland was included in the analysis; land that is leased by Temple-Inland for the purpose of fiber production was not included, as this analysis focused on the long term perspective of evaluating the economic characteristics of land management.

Although the criteria of measurement for determining whether a tract of land is non-contributory is its estimated economic return from the production of pulpwood and sawtimber, it is not the intent of this analysis to isolate, or recommend for disposal those lands currently designated for management for purposes other than fiber production. Lands having such alternative management goals may include streamside management zones, endangered or threatened species habitat, distinctive sites, etc. However it is worthwhile to identify and recognize the potential economic burden placed upon the firm by such management. This recognition should help to increase awareness of the economic cost of these management objectives, which should help with future decisions regarding management objective assignments.

It is also widely recognized that Temple-Inland owns lands that have an open market value significantly greater than what can be achieved from management for fiber. These lands will also be identified, and an appropriate strategy developed to take advantage of that value. The process for identifying these acres is different than that used to identify non-contributory acres, and is not addressed here.

METHODOLOGY & MODEL DESCRIPTION

There are three phases to this project:

Phase I Those **tracts** in the Forest that appear to have an unacceptable earnings potential were identified. A model was developed that provides the approach for evaluating the earnings potential for **tracts** assuming they are to be managed for timber production. **The three main drivers in this model are 1) Current land use classification, 2) Site Quality, and 3) The percentage of productive acres within a compartment.** Additionally, **tracts** are analyzed based on their proximity to other **tracts**. This proximity screening will help to identify access issues should it be decided to dispose of the **tract**. It is recognized that this process will be repeated periodically as management methods and fiscal expectations change over time.

Phase II Each tract on this list was then reviewed by the respective management forester to determine whether disposal is the appropriate action to take. This involved verification of current stand conditions and projected harvest timings, assessment of market conditions, proximity to adjacent landowners for trade purposes, etc.

Phase III The third phase concerns the identification of **tracts** that have a market value significantly greater than what can be achieved from the production of timber. The identification criteria and methods are fundamentally different than those included in Phase I, yet the earning potential of each **tract** does serve as a baseline to which the market value is to be compared to determine if the **tract** is of a higher value. The process of higher value determination is not addressed here.

DATA

This model focuses on the *compartment* as the unit of measure for economic productivity. Temple-Inland Forest defines a compartment to be a collection of one or more homogeneously-managed tracts called *stands*. While the *stand* is a unique entity, and has a complete data description, the compartment was the better choice for determining productivity. There are two primary reasons for this: first, streamside management zones (SMZs) are considered separate stands. Yet due to their spatial distribution within any portion of a landbase, it is often inherently impossible to separate an SMZ from the adjoining stands for purposes of ownership change considerations. Secondly, stands are continuing to decrease in size as a result of harvest layout procedures suggested by the Sustainable Forestry Initiative (SFI) (AF&PA 2002). Yet these smaller stands within a compartment often have very similar characteristics, as they were separated from former larger stands more for size reasons rather than homogeneity of growth potential characteristics. For ownership considerations, these stands should be treated as a group. Therefore, the compartment becomes the logical unit of performance measurement, and the challenge is to integrate the estimated performance potential of the individual stands within a compartment, including SMZs, to a single measure representing the entire compartment. There are approximately 3,400 compartments in Temple-Inland's Western Forest, containing approximately 17,000 stands. In Tempe-Inland's Eastern Forest, 628 compartments contain approximately 2,500 stands. Figure 1 portrays a grouping of three adjacent compartments, along with each compartment's stands.

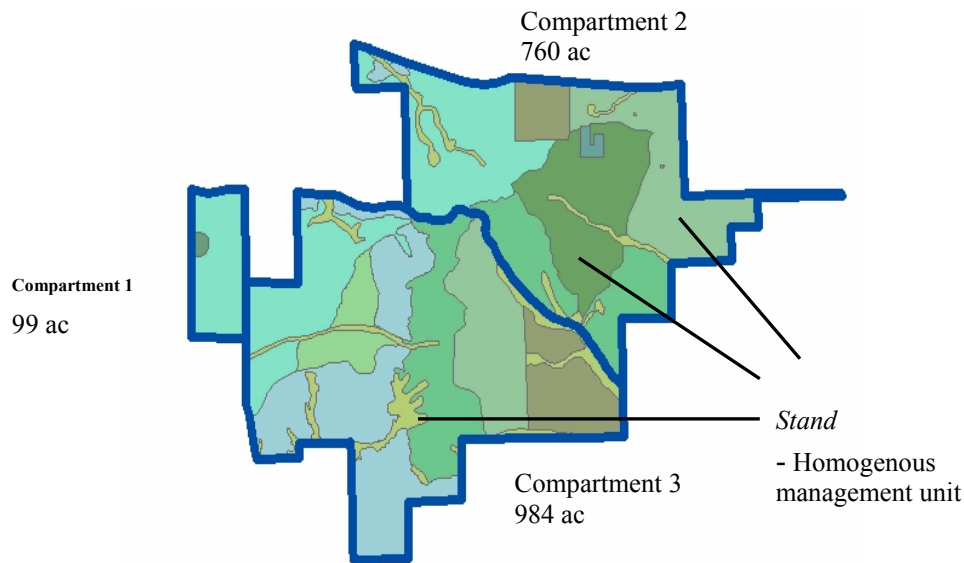


Figure 1. Three adjacent compartments, along with their stand boundaries.

Land Classification & Site Quality

Temple-Inland has developed a land classification system that categorizes the landbase into strata based upon each stand's establishment history and the current management practices utilized on the stand to achieve its stated objectives. Certainly the management objectives for any particular stand are not permanent. Temple-Inland can, and does alter individual stand objectives periodically to better conform to corporate policy, business objectives and environmental considerations. It is worth repeating that this analysis evaluated stands and compartments based on their *current* usage classification. Some of these management classifications are: pine plantation utilizing a clearcut final harvest; naturally-established pine stand with single-tree selection harvest; naturally-established hardwood stand with single-tree selection harvest; aesthetic management zone; streamside management zone; etc.

Earnings potential was measured by the internal rate of return (IRR) of the stand. IRR was determined differently for each stand classification type. For pine plantations the present net worth (PNW) of an infinite series of optimal rotations was calculated. The quality of the site is represented by its measured loblolly (*Pinus taeda*) or slash pine (*Pinus elliottii*) site index, base age 25. Site index was rounded to the nearest ten feet, and plantation IRR values were calculated for each ten foot increment within the range of existing site indices.

Management Assumptions

In order to determine approximate returns for plantations of various site indices, some general assumptions related to the management activities for the different site classes were made,

with the knowledge that in reality our forest management is site specific. A regime was modeled reflecting the typical site preparation methods, nutrition enhancements, competition control measures and stocking management methods currently employed by Temple-Inland. Current cost figures for these treatments were applied. Applicable ad valorem tax rates for the county in which each particular plantation is located, along with a generalized management overhead cost were also included. Revenues represented by harvested pine products and hunting leases were modeled. For naturally-established pine and hardwood stand types the present net worth of repetitive selection harvests using typical yields and management considerations was calculated.

For pine plantations, it was assumed that the stand was in a bare ground condition, hence the usage of a Land Expectation Value (LEV) measure that analyzes an infinite series of rotations given a starting point of bare ground. The *net present value* (NPV) method of stand valuation incorporates the discounted value of the existing rotation as well as the value of the ground for an infinite series of rotations. Utilizing the NPV method results in values equal to the LEV if the tract is in a bare dirt state, up to values approaching several thousand dollars if there currently exists a mature stand of high value products. The reason in this analysis for not measuring the value of the existing rotation is that tracts containing young stands would categorically receive substantially less value than tracts with mature timber, almost regardless of any other condition of the site. Therefore, for the purpose of identifying acres that do not contribute an acceptable return, the resulting set of identified tracts would have been comprised mainly of young stands. This bias is fundamentally flawed, as it defies all common definitions of sustainable forest management. It does not permit the determination of long term earning potential. To prevent the dominance of such a short term bias all current stocking conditions were ignored in the analysis. Once a compartment is identified as non-contributory, the current stocking conditions may then have a bearing on the timing of disposition, or change of management objective.

Productive Acres

Total Stand Acres can be defined simply as the total acreage within the stand. This is the figure used for all computations related to the cost of ownership, such as depletion and ad-valorem county property taxes. *Net Stand Acres* refers to those acres within a stand that are actually managed for fiber production. Net stand acres do not include right-of-way easements, ponds, woods roads, or other such acreages that are not manageable for the purpose of growing trees. The proportion of net stand acres to total stand acres is applied against the stand's inherent productivity rating. The implication of this is that compartments with a lower aggregate ratio of net to total acres in their stands will have a lower earning potential, all other criteria being equal.

Model Structure

The following algorithm describes the methodology used to arrive at a single value representing compartment earning potential. This algorithm is portrayed in Figure 2.

1. For each stand, any acres within the stand designated as *Special Use* were subtracted from the stand's Net Acres. This figure is the stand's *Productive Acres*.
2. If the stand is a pine plantation, the *Site Class* value is assigned the site index (base age 25) value rounded to the nearest 10 feet.
3. An IRR value, or *Stand Earning Potential*, is assigned to each stand based on its current management objective. For pine plantations, this value is commensurate with the Site Class.
4. For pine plantations, the effect of annual county property tax payments represents an approximate burden of -0.14% IRR for each \$1 per acre paid. Therefore, 0.14% is subtracted from the stand's IRR for each \$1 of county taxes, net of any hunting lease revenue per acre for tracts in that county. The -0.14% burden was assumed to be consistent across all stand types.
5. For each stand, Productive Acres is multiplied against the net IRR value, to get a *Weighted Productive Acre* value.
6. Weighted Productive Acres are then summed together for each stand within a compartment, and this result is divided by the sum of the compartment *Total Acres* to derive the expected earning potential of all acres within the compartment.

$$\text{CEP} = \frac{\sum(\text{SEP} * \text{SPA})}{\text{compartment total acres}}$$

where:

- CEP = compartment earning potential
- SEP = stand earning potential
- SPA = stand productive acres = stand net acres – special use acres

Figure 2. Basic algorithm to calculate compartment earning potential.

Temple-Inland forestland is organized into two distinct regions – East Texas/West Louisiana and Northwest Georgia/Northeast Alabama. One differentiating characteristic between the two regions is that the forestland in the West tends to be grouped into larger blocks of contiguous compartments compared to the forestland in the East, which tends to be grouped into smaller blocks of contiguous compartments. Any given compartment in the West is more likely to be immediately adjacent to one or more other compartments relative to any given compartment in the East. For a compartment whose computed earning potential is below a requisite threshold, whether or not that compartment is contiguous to another compartment can have a significant impact on the decision to dispose of or retain the compartment. In general, a compartment that is immediately adjacent to another compartment is more difficult to

recommend for disposition; this is particularly true for a compartment that is completely embedded within a set of surrounding compartments.

Therefore in the analysis of compartments in East Texas/West Louisiana a geographic information system (GIS) was used to define the *adjacency status* of each compartment as: adjacent to one or more other compartments; within 500 feet of, but not immediately adjacent to another compartment; or at least 500 feet away from the nearest compartment. This characteristic was not included in the algorithm to determine earning potential, but was provided as an indicator of isolation to assist the management forester in assessing compartments prioritized in the analysis.

RESULTS & DISCUSSION

The product of the analysis was a listing of all compartments, ranked by calculated earning potential. It was then incumbent upon the different management foresters to review those compartments ranked at the lower end of the scale. An automated spreadsheet tool was developed to query this list and assist the forester in his/her review of those compartments by populating a worksheet with all data representing the factors included in the formulation of the earning potential estimate for each stand within the compartment chosen for review, along with a collection of other data elements related to the compartment's stands that might assist the forester in their review and disposition/retention decision.

In some cases, the numbers by themselves were interesting, but were mostly in-line with expectations. However, two welcome surprises are coming out of the results review process. While Temple-Inland Forest prides itself on the quality and consistency of its forest data, it is nevertheless impossible to have a data system comprised of some 19,500 stands that is without errors. While some errors are obvious, others are subtle, and can be difficult to detect. When a particular compartment is identified as being an economic under-performer, its data becomes closely scrutinized. This review quite often reveals data errors that would otherwise have gone unnoticed. Regardless of the impact of the error on the result of the calculated economic performance, the system is improved each time an error is identified and corrected.

A second unforeseen benefit resulting from the review process is the new light, or sense of urgency placed on compartment organization. Two or more adjacent compartments may all have marginally acceptable ratings. However, there may be two or more adjacent stands, each belonging to a different compartment, and each with a poor earning potential, that could be grouped together into one block and disposed of, or otherwise be managed differently to better achieve economic objectives.

CONCLUSION

In an effort to assess and improve the economic efficiency of the forestland of Temple-Inland, an analysis process was developed to estimate the earning potential of every compartment of land. The algorithm to estimate earning potential was based on stated management objectives of the land, the inherent productivity of the land, and the proportion of each compartment that is actually capable of growing commercially-viable trees. Once earning potential ratings were developed, those compartments having unacceptable ratings were closely scrutinized by their respective management forester for data accuracy, suitability for alternative management, or for disposition. The importance of this hands-on review process cannot be overemphasized. It is here that both the most data errors are found, as well as the greatest creativity for optimizing the economic potential of each compartment. It must be emphasized that this is one tool that has helped to evaluate a very large and complex asset. It is by no means expected to be the definitive tool; other processes have and will continue to be employed to routinely assess the performance of the company's forestland. Finally, this exercise should be periodically repeated. Management objectives and the criteria for success change over time; database errors do have an impact, and are always present and recurring.

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Applying Modern Portfolio Theory to Timberland Allocation

Bruce Carroll¹

Abstract: Significant research has gone into developing models showing the appropriate mix of equity investments to optimize risk-adjusted returns. These optimal portfolios often have a mix of stocks, bonds, and cash. Increasingly, institutional investors are looking for other alternative investments to increase the return or lower the risk of their investment portfolios. Real estate assets, including timberland, are one of the asset classes that many institutional investors, particularly large pension funds, have used to improve their risk-adjusted returns. Due to low correlation between timberland investments and equity investments, timberland has a high probability of success in improving portfolio risk adjusted returns.

To gain insight into this issue, a Markowitz portfolio optimization technique was used to calculate the optimal mix of timber investments across geographies when mixed with traditional investments. The timberland asset class will be broken into three geographic components Pacific Northwest, Southeast, and Northeast. To compare the impacts addition of composite and regional timberland allocations, models were built using 1) equities only, 2) equities plus composite timberland returns, and 3) equities plus the three regional geographic timberland indices. A Markowitz portfolio optimization model was built using various combinations of these assets.

Key Words: timberland portfolio optimization, Markowitz, modern portfolio theory

INTRODUCTION

Researchers and portfolio analysts have spent considerable effort developing models showing the appropriate mix of equity investments to optimize risk-adjusted returns. These optimal portfolios often have a mix of stocks, bonds, and cash, often including an international component used to reduce risk or boost returns. Increasingly, institutional investors are looking for other alternative investments to increase the return or lower the risk of their investment portfolios.

Timberland has been shown to have a low correlation with equities (Binkley et al 2001). As such, it is a good candidate for addition to an optimal portfolio to improve risk-adjusted returns. As stated by Markowitz (1952), “in trying to make variance small it is not enough to invest in many securities. It is necessary to avoid investing in securities with high covariances among themselves” Thus investments in timberland have a high probability for success in improving portfolio risk adjusted returns.

In addition, some research has shown that it improves overall portfolio returns in addition to reducing risk (Binkley et al 2001, Caulfield 1999). Most of the research published uses a single option for timberland investment (a composite timberland return). Little research has been published that shows the optimal mix of timberland investment across geographic areas of the United States. Caulfield (1999) states that, “Although research on timberland as a portfolio asset is potentially useful by TIMCOs for the construction of timberland portfolios, it is seldom employed to this end.”

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A Markowitz portfolio optimization technique was used to calculate the optimal mix of timber investments across geographies when mixed with traditional investments. The following asset classes were used 1) U.S. equities - [Wilshire 5000 Total Return Index] and 2) Foreign equities [Morgan Stanley Europe Asia Far East Index –EAFE], 3) timberland. The timberland asset class is broken into three geographic components Pacific Northwest, Southeast, and Northeast. To compare the impacts addition of composite and regional timberland allocations, models were built using 1) equities only, 2) equities plus composite timberland returns, and 3) equities plus the three regional geographic timberland indices. A Markowitz portfolio optimization model was built using various combinations of these assets. The model was run for multiple iterations to create an efficient frontier. The capital market line was added and the optimal risk adjusted portfolio of traditional equities and geographic timberland investments were identified.

Data for the timberland asset classes will be obtained from the National Council of Real Estate Investment (NCREIF) Timberland Property Index. Data for this index is available quarterly back to 1987. However, the Northeast index values only start in 1994. In order to fully study the impact of regional timberland allocations the study looked at data from 1994 onward.

METHODOLOGY

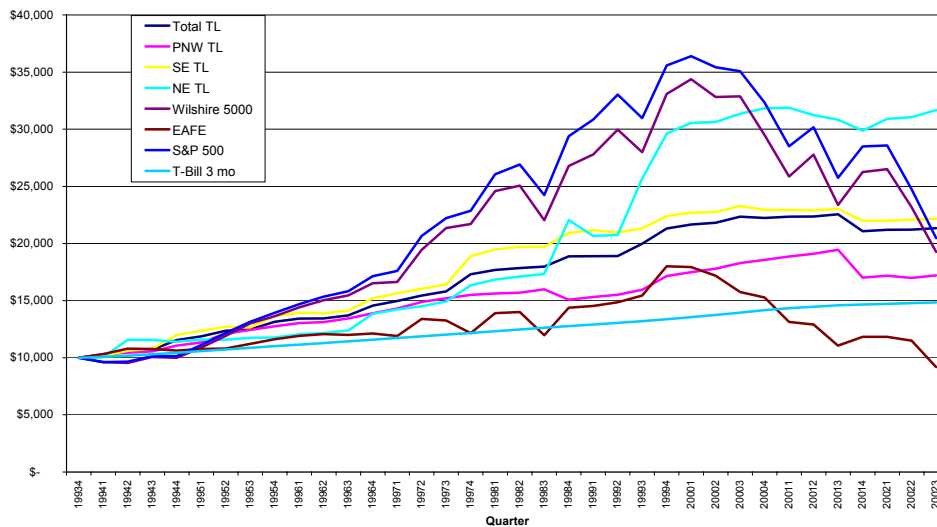
Return data for U.S. timberland investments was obtained from the National Council of Real Estate Investment Fiduciaries (NCREIF). NCREIF produces a Timberland Property Index, which details quarterly performance results. This data includes a Total Timberland Index as well as three regional sub indices for Southeast, Pacific Northwest, and Northeast (NCREIF 2002).

Return data for U.S. stocks was derived from the Wilshire 5000 index. This index is the broadest index available for the U.S. equity market (Wilshire 2000). Quarterly returns with dividends reinvested were selected to match the return data for the NCREIF Timberland Property Index. For comparison purposes return data for the Standard & Poor's 500 Total Return Index was also obtained (Federal Reserve 2002).

Return data for international stocks was derived from the Morgan Stanley Europe Asia Far East Index. The MSCI EAFE Index is an unmanaged index of common stocks in Europe, Australasia and the Far East and includes dividends but is net of withholding taxes (Morgan Stanley 2002). To provide an estimate of the risk free rate for the same time period of analysis 3-month T-Bill rates were obtained (Federal Reserve 2002).

Recent equity and timberland performance has been quite variable. Equity asset values peaked in the first quarter of 2001 and have fallen substantially since that time (Exhibit 1). Similarly institutional timberland investments as evidenced by the NCREIF Timberland Property Index peaked between the first quarter of 2001 and the third quarter of 2001 depending on the region in question. Because of this recent behavior two different time periods were studied. The first period covers the 5-year period from first quarter 1994 through the fourth quarter 1998. The second period covers first quarter 1994 through third quarter 2002. The NCREIF Timberland Property Index covers the time period from first quarter 1987 through the present. However, the Northeast regional sub index is only available from first quarter 1994. Since the main purpose of this study is to look at the impact of regional allocations of timberland it was decided to start the analysis from this point.

Exhibit 1: Growth of \$10,000 for Various Timber and Non-Timber Assets



Five Year Results

An analysis of the return over the 5-year period from January 1, 1994 through December 31, 1998 shows that the Wilshire 5000 index was the best performer of our mix of assets with a geometric mean return of 20.2%. This was followed by Northeast Timberland (16.1%), Southeast Timberland (15.0%), Total Timberland (12.9%), Pacific Northwest Timberland (8.3%), and the Morgan Stanley EAFE (7.3%). For comparison, the Standard & Poor's 500 Index outperformed all of these assets with a 22.2% geometric mean return and the 3-month T-Bill returned the least with a 4.9% geometric mean return.

While the timberland assets proved to under-performed the U.S. equity assets they did so with significantly less volatility. Standard deviations ranged from 2.3% for Pacific Northwest timberland to 6.7% for Northeast timberland with all except the Northeast falling below 3.8%. This compares favorably to the Wilshire 5000 Index and the Morgan Stanley EAFE both at 7.2%. This low volatility of returns is not surprising given the unique characteristics of institutional timberland investments. The biological nature of these timberland resources causes the total inventory, thus value of these resources to increase over time – breaking the return correlations (Whitaker et al, 1999).

One important aspect of timberland as an alternative asset class in a portfolio optimization framework is its low or negative correlation to other assets. As shown below (Exhibit 2) the NCREIF Total Timberland Index correlation with other assets varies from negative 0.03 (with the Morgan Stanley EAFE Index) to 0.13 (with the T-Bill). Pacific Northwest timberland has negative correlations (from -0.45 to -0.31) with all except the T-Bill (0.38). Southeast timberland correlation has a low of negative 0.06 (with Morgan the Stanley EAFE) to a positive 0.10 (with the T-Bill). Finally, the Northeast timberland has the highest correlations with traditional equity assets (varying 0.38 to 0.46) and a negative correlation with the T-Bill (-0.37). By comparison the correlations between the Wilshire 5000 and the other two equity assets is between 0.81 (Morgan Stanely EAFE) and 0.99 (Standard & Poor's 500). Thus,

all of these timberland assets make excellent candidates for inclusion in an optimal portfolio due to their relatively low correlations and high return characteristics.

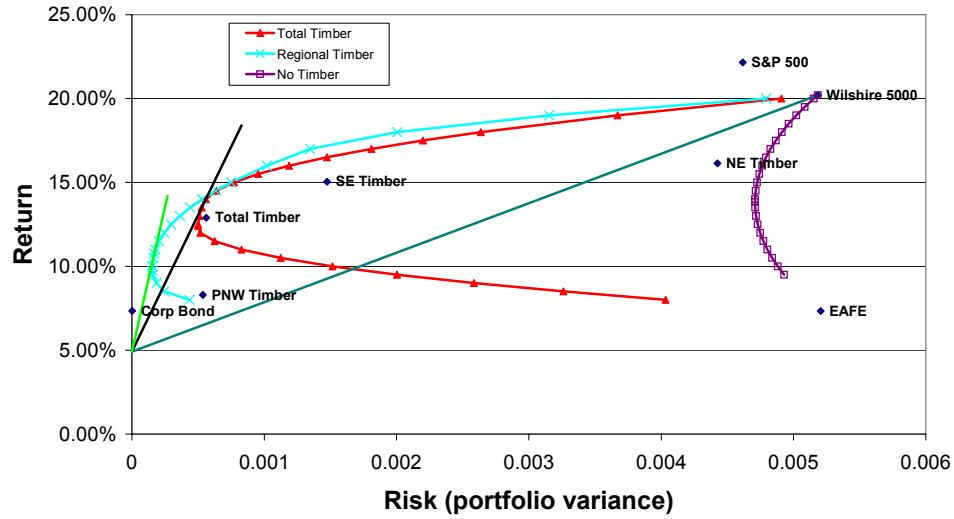
Exhibit 2: Performance Data for Timberland and Equity Assets - 1994 to 1998

	Total TL	PNW TL	SE TL	NE TL	Wilshire 5000	EAFE	S&P 500	T-Bill 3 mo
Annual Return	12.9%	8.3%	15.0%	16.1%	20.2%	7.3%	22.2%	4.9%
Variance	0.0006	0.0005	0.0015	0.0044	0.0052	0.0052	0.0046	0.0000
Standard Deviation	2.4%	2.3%	3.8%	6.7%	7.2%	7.2%	6.8%	0.1%

Correlation Based on Quarterly Returns (1994.1 to 1998.4)								
	Total TL	PNW TL	SE TL	NE TL	Wilshire 5000	EAFE	S&P 500	T-Bill 3 mo
Total TL	1.00							
PNW TL	0.15	1.00						
SE TL	0.97	0.03	1.00					
NE TL	0.32	(0.71)	0.33	1.00				
Wilshire 5000	0.08	(0.31)	0.03	0.38	1.00			
EAFE	(0.03)	(0.45)	(0.06)	0.46	0.81	1.00		
S&P 500	0.12	(0.32)	0.07	0.41	0.99	0.82	1.00	
T-Bill 3 mo	0.13	0.38	0.10	(0.37)	0.23	(0.20)	0.25	1.00

Given that the low correlations would make timberland a good candidate for inclusion in a portfolio, three cases are examined. First, a portfolio containing no timberland, second a portfolio containing the NCREIF Total Timberland Index, and third a portfolio excluding the Total Timberland Index but including the three NCREIF regional sub indices. In each case minimum variance portfolios were constructed across a range of required rates of return (Markowitz 1952). This “efficient frontier” of alternative portfolios provides the universe from which portfolio allocations should be made. Shown below are the results of this analysis (Exhibit 3). For comparison purposes the returns and volatility of the individual assets are included. The portfolio containing only equity assets provides an alternative with the highest overall returns. This portfolio also has the highest risk as measured by portfolio variance. Because of the extremely low correlations between these equity assets and the timberland returns, portfolios can be constructed that provide considerably better risk/return characteristics.

Exhibit 3: Minimum Variance Portfolios for Equity and Timber Investments - 1994 to 1998



The portfolio constructed using the Total Timberland Index has considerably less risk than the equity only portfolio. The minimum variance portfolio has a geometric mean return of 12.4% with a standard deviation of 2.23%. The portfolio constructed using the individual regional subindices yields a geometric mean return of 9.74% with a standard deviation of 1.24%.

Exhibit 4: Characteristics for Minimum Variance and Optimal Portfolios - 1994 to 1998

		No Timber	Total Timber	Regional Timber
Minimum Variance Portfolio	Return	13.84%	12.40%	9.74%
	Variance	0.0047	0.0005	0.0002
	Standard Deviation	6.86%	2.23%	1.24%
Optimal Portfolio	Return	20.20%	13.50%	10.75%
	Variance	0.0052	0.0005	0.0002
	Standard Deviation	7.20%	2.30%	1.30%
Optimal Portfolio Weights	Total TL	0%	90%	0%
	PNW TL	0%	0%	71%
	SE TL	0%	0%	2%
	NE TL	0%	0%	20%
	Wilshire 5000	100%	9%	6%
	EAFE	0%	1%	0%

The “separation principle” says that the investor can make two separate investment decisions. First, the investor selects the point on the efficient frontier at which to invest. Second the investor makes a choice of whether to leverage his investment to improve return by borrowing at the risk-free rate, or to reduce his risk by investing a portion of the investment in the risk-free asset (T-bills). Informed, risk adverse investors will buy a portfolio where the capital market line touches the efficient frontier since it provides the maximum return at the least amount of risk. Capital market line is formed using the geometric mean return for T-Bills (4.92%) over the same investment horizon and forming a line tangent to the efficient frontier. This tangency point is shown for each of the three investment portfolios and the optimal portfolio weights are indicated in Exhibit 4.

It can be seen from Exhibit 3 that for much of its length the efficient frontier formed with regional timberland allocations performs better than the one formed with the Total Timberland Index only. This implies that the total timberland index contains a sub optimal mix of timberland assets for optimal portfolios and would lead to incorrect decisions regarding optimal portfolio allocation. We observe this in the allocation example with allocation to the Total Timberland Index determined to be 90% but the sum of the more detailed allocations to the regional timberland sub indices totaling 94%.

Life of Index Results

Next we look at results over the life of the Northeast regional sub index (1994 through the third quarter 2002). Over this investment time frame the situation is quite different. Beginning in the first quarter of 2001 the equity indices fell quite spectacularly while the institutional timberland assets fell less dramatically. The geometric mean return for the NCREIF Total Timberland Index as well as most of the regional sub indices outperform our two equity investments the Wilshire 5000 and the Morgan Stanley EAFE Index as well as the benchmark Standard & Poor’s 500 Total Return Index. However, the Pacific Northwest sub index is outperformed by the Wilshire 5000, and the S&P 500 Index.

Exhibit 5: Performance Data for Timberland and Equity Assets - 1994-Q1 to 2002-Q3

	Total TL	PNW TL	SE TL	NE TL	Wilshire 5000	EAFE	S&P 500	T-Bill 3 mo
Annual Return	8.8%	6.2%	9.2%	13.4%	7.6%	-1.0%	8.3%	4.5%
Variance	0.0008	0.0010	0.0013	0.0048	0.0087	0.0068	0.0079	0.0000
Standard Deviation	2.8%	3.2%	3.6%	6.9%	9.3%	8.3%	8.9%	0.3%

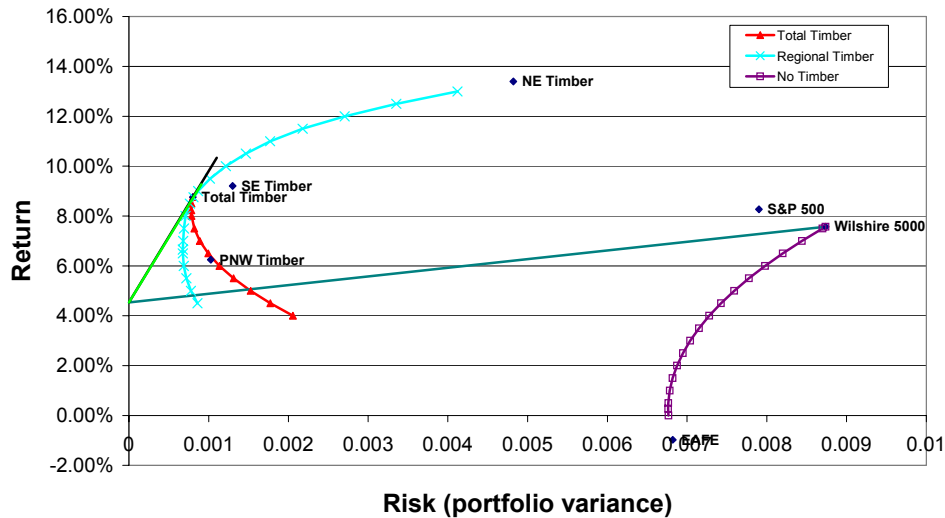
Correlation Based on Quarterly Returns (1994.1 to 2002.3)								
	Total TL	PNW TL	SE TL	NE TL	Wilshire 5000	EAFE	S&P 500	T-Bill 3 mo
Total TL	1.00							
PNW TL	0.60	1.00						
SE TL	0.91	0.35	1.00					
NE TL	0.53	(0.02)	0.38	1.00				
Wilshire 5000	0.19	(0.09)	0.21	0.24	1.00			
EAFE	0.19	(0.13)	0.14	0.44	0.83	1.00		
S&P 500	0.22	(0.08)	0.25	0.24	0.99	0.83	1.00	
T-Bill 3 mo	0.42	0.50	0.32	0.07	0.28	0.15	0.34	1.00

The standard deviation of returns also increased in almost every case. The one exception is the Southeast timberland sub index, which dropped from a standard deviation of 3.8% to 3.6%. The remainder increased by between 4% (Northeast timberland) to 38% (Pacific Northwest timberland) with the volatility of the equity indices increasing more on average than the timberland indices.

The other change in the data is that over this longer (almost 9 years) time frame the correlation between the timberland assets and the equity assets increased. While the correlations are higher they are still quite low and still provide diversification benefits. Shown below (Exhibit 6) are efficient frontiers for each set of investments. The inclusion of either the NCREIF Total Timberland Index, or the set of regional sub indices do prove to provide substantial diversification benefits. The investment portfolios that include timberland provide higher returns with significantly reduced risk. The all equity portfolio is *dominated* by the portfolio that includes combinations of the three timberland sub indices and the two equity indices.

It is also interesting to note that the portfolio that includes the NCREIF Total Timberland Index plus equities is *dominated* over its entire length except for the single point where the entire portfolio is comprised of timberland. This point is also the tangency point for the regional timber portfolio. This result is to be expected since the efficient market hypothesis would lead investors to select a mix of timberland investments that minimize portfolio variance in a mixed asset portfolio.

Exhibit 6: Minimum Variance Portfolios for Equity and Timber Investments – 1994-Q1 to 2002-Q3



The minimum variance portfolio for the mix of assets that include the NCREIF Total Timberland Index has a minimum variance where the portfolio consists of only timberland and provides a return of 8.23% with a standard deviation of 2.8%. The optimal portfolio for this mix of assets includes 100% timberland with the standard deviation increasing only to 2.83% while the return increases to 8.76%. This was determined as before by finding the tangency portfolio but this time using a revised risk free rate of 4.65% for this time interval.

The minimum variance portfolio that includes the regional timberland sub indices has a geometric mean return of 6.65% with a standard deviation of 2.6%. The optimal portfolio for this mix of assets returns 8.75% with a standard deviation of 2.85%. In stark contrast the minimum variance portfolio that includes no timberland returned only 0.27% and had a standard deviation over 3 times higher (8.22%). Similarly, the standard deviation of the optimal no timberland portfolio is over three times higher than the regional timberland mixed asset portfolio while providing a lower return (7.57% versus 8.75%).

Exhibit 7: Characteristics for Minimum Variance and Optimal Portfolios – 1994-Q1 to 2002-Q3

		No Timber	Total Timber	Regional Timber
Minimum Variance Portfolio	Return	0.27%	8.23%	6.65%
	Variance	0.0068	0.0008	0.0007
	Standard Deviation	8.22%	2.80%	2.60%
Optimal Portfolio	Return	7.57%	8.76%	8.75%
	Variance	0.0087	0.0008	0.0008
	Standard Deviation	9.35%	2.83%	2.85%
Optimal Portfolio Weights	Total TL	0%	100%	0%
	PNW TL	0%	0%	40%
	SE TL	0%	0%	38%
	NE TL	0%	0%	19%
	Wilshire 5000	100%	0%	3%
	EAFE	0%	0%	0%

As can be seen from Exhibit 7 above, the optimal regional timberland allocation totals 97%. This is made up of 40% Pacific Northwest timberland, 38% Southeast timberland, and 19% Northeast timberland. The remainder of the assets (3%) are allocated to the Wilshire 5000 Index.

On closer examination of the data that makes up the NCREIF Total Timberland Index and its sub indices we find that the mix of timberland investments reported in the index does not match the regional portfolio allocation derived here. The market value weighted components of the NCREIF index are \$2,617.2 million Southeast (70%), \$916.8 million Pacific Northwest (25%), and \$203.4 million Northeast (5%).

CONCLUSIONS

It is clear from the examples provided that adding timberland to a portfolio of equity assets improves the risk return profile of the portfolio. It also points out the importance of portfolio rebalancing since the allocation to timberland, and the allocation to each regional timberland sub index changes depending on the time period selected.

Thomson (1997) studied the impacts of holding mixed asset portfolios containing timber over long time periods. Rather than using actual reported timberland returns he constructed theoretical timber return benchmarks for Douglas fir and Southern pine using historical timber prices. Results of this study showed that optimal timber allocation varied substantially period to period with timber allocations over 50% common in the 1943 to 1957 period (Thomson 1997). The allocation to Douglas fir and Southern pine also varied over time. This confirms the importance of portfolio rebalancing to match new risk and return expectations over time.

As discussed in Markowitz (1952), one “should combine statistical techniques and the judgment of practical men.” No attempt to make adjust the variance or expected return values in this purely theoretical discussion. However, adjustments may be warranted. For example it is unlikely that the Morgan Stanley EAFE index will continue to produce negative results for the next 5 years. In addition, some issues exist with the use of quarterly NCREIF Timberland Property Index results. The NCREIF Timberland Property Index is an appraisal-based system. Since most appraisals happen at year-end the index may underestimate the true volatility of these timberland investments (Lutz 2001, Lowery 2002). Use of these methods to determine actual portfolio allocations should take these issues into consideration.

The methods used here could be extended to provide insight into broader issues of portfolio allocation. To provide easy to understand insight into the timberland allocation issue only two non-timberland assets were included in the portfolio mix. This analysis could be extended to include more financial assets in the investment mix. For example, one could include various other standard equity U.S. indices (e.g. Russell 2000, Nasdaq Composite, S&P 500, S&P MidCap 400 Index, S&P SmallCap 600) as well as corporate or U.S. Treasury bonds. It could also include more diversity in the international exposure by including the Morgan Stanley Emerging Markets Free Index, or by including various country indices (e.g. FTSE 100, Nikkei 225, Hang Seng, Xetra Dax, Cac 40, TSE 300). Including these other equity indices would more closely match the investment universe of the institutional investor and provide more insight into the appropriate regional timberland and non-timber portfolio allocations.

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Impacts of Inaccurate Area Estimation on Harvest Scheduling Using Different Image Resolutions

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Abstract: Area estimation is widely used in forestry applications and can greatly affect how forest land is managed. This study examined whether image attributes and interpreters affected area estimation and management activities used in forestry practices. Seven interpreters, chosen for this study, delineated stands on two different images of the same area. Results from these interpretations were then entered into a harvest scheduling model to see how the differences affected the overall timber value predicted by the harvest schedule. Image attributes played a role; however, differences in interpretation were the primary cause of inconsistency in harvest values. The objective function values (OFV) for individual interpreters ranged from \$1.5 to \$2.3 million for Positive Systems® imagery and \$1.4 to \$1.9 million for scanned imagery. Average OFV between imagery and interpreters ranged from \$1.7 to \$1.8 million.

Key Words: image resolution, forest management, harvest scheduling, remote sensing, area estimation, GIS

INTRODUCTION

Many factors lead to proper forest management planning. For instance, stand delineation is an important factor in determining attributes of forest land. Stand delineation can influence the allocation of specific forestry practices and determine the acreage assigned to timber types on the site. Another major factor in forest management planning is area estimation. Area estimation is used to calculate volumes on a stand or forest level, and these volume estimates are used for appraising timber values. Area estimation does not affect rotation ages; however, it may affect appraisal prices for a property. With timber values, forest land can be assessed as economically mature or immature which can in turn affect harvest timings. Therefore, care should always be taken when predicting areas from stand interpretations. Payments, such as taxes and insurance, are made according to standing timber values and can be affected if areas are incorrectly delineated. Finally, delineation errors affect timber and land values and can cause problems for other aspects of forest management. For example, harvest schedules are determined by allocating resources to certain management strategies; therefore, these schedules may be sub optimal if area estimates are inaccurate. In addition, goal attainment may be adversely affected. This study focuses on the direct effect of all these factors on harvest scheduling results for a specific piece of property.

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³ Funding provided by Mississippi State University, Department of Forestry and NASA, Environmental Department. Approved for publication as Journal Article No. FO242 of the Forest and Wildlife Research Center, Mississippi state University.

The study location contains many stands of various types and composition. This area is currently managed by the U.S. Army Corps of Engineers for forestry and aesthetic uses, specified by the National Aeronautics and Space Administration (NASA). Space shuttle engine tests are the main use of this area.

Typically, aerial or satellite imagery is necessary for stand delineation. However, spatial resolution can affect area estimation. Repetitive stand lines on an image are identified using characteristics that are visible to the eye and may be incorrectly depicted because of detail lost to resolution differences. Differences between high and low resolution imagery need to be addressed to ensure that forest management decisions are appropriate.

With information on the effects area estimation has on land management, managers can adjust treatments to include errors made in area estimation. In addition, with activities being planned over extended periods of time, managers will be able to see the long-term effect caused by area estimation errors. Since monetary returns are commonly used for comparing management alternatives, information on the economic impacts of using certain types of imagery is a problem facing natural resource managers. Images of different resolutions may produce different interpretation results. However, if results do not differ, it makes sense to use imagery that has the lowest cost.

The objectives of this study are to: 1) estimate stand areas, using different imagery 2) develop a linear programming (LP) model that can be used for management planning, and 3) conduct a comparative analysis to assess imagery impacts on forest management planning. This analysis compared harvest schedules, using the same LP model, taken from both image types.

Area Estimation

Techniques that estimate land area from imagery generate errors that cause problems for land managers. Shadows thrown from objects above the earth's surface can cause problems in determining boundaries. Resolution and quality of an image are factors that contribute to inaccuracies in delineated stand boundaries. All of these factors greatly affect area estimation; however, little research has been done that relates these errors to forest management planning. Land managers and private landowners can ensure that optimal management decisions are made for their land by knowing how harvest schedules are affected by area estimation.

Conducting research on area estimation requires forest land to be broken up into stands for data collection and analysis. Volume estimates per unit depend on the actual area estimate along with the volume estimated for that site. Photo interpretation is a common way of determining areas from an image (Naesset 1999). Models are then used to determine delineation errors caused while drawing boundaries. Naesset (1999) used Monte Carlo simulation techniques to quantify positional errors. He determined that many factors can contribute to errors in area estimation. For instance, stands that are uniform are easier to distinguish than stands of varying tree species and density. Therefore, the difference in stand characteristics plays a role in determining stand boundaries. Naesset (1999) used the following classes: regeneration stage forest, thinning phase forest, non-productive, swamp, and lake. After these classes were determined, the area was broken up into stands and inventoried. Positional errors occurred where stands that were similar in species type and density adjoined. Also, tree shadows were a problem for boundary determination in stands where mature trees overshadowed younger stands. After stand boundaries were determined they were registered into pcARC/INFO. For all but the thinning phase forest, area estimates overestimated the area when compared to the true area.

The main approach for forest area estimation in the past has been interpretation of aerial photographs; however, that is currently changing due to satellite imagery use. Commonly, an area must be at least 10% forested and at least 1 acre to be considered a forest in the federal inventory system (Wynne et al. 2000). Advantages of satellite images include easier analysis of imagery due to software packages, larger views of an area, and satisfying the increasing need for frequent updates due to the ever-changing landscapes (Wynne et al. 2000).

Selecting the type of imagery to be used in research, and how to interpret that image, depends on the project goals and budget restrictions. Characteristics of an image that need to be addressed include spatial resolution, spectral resolution, temporal resolution, and extent. Spatial resolution refers to the smallest object on an image that can be identified. Green (2000) defined spectral resolution as portions of the electromagnetic spectrum sensed by a satellite and the number and width of bands. Temporal resolution describes when and at what time intervals an image is captured. Extent refers to the amount of area covered by one image (Green 2000).

High-resolution imagery supplies detailed representations of site-specific qualities. By having detailed imagery, it is possible to monitor pest damage to individual trees, distinguish forest types, determine wildlife habitat, and assess fire management operations. Seven indicators used for manual interpretation of images are color, tone, texture, shape, size, pattern, and context of the feature of interest (Green 2000). Therefore, distinguishing between each of these indicators requires the use of high-resolution imagery. Pixel size plays a major role in the accuracy of area estimates by limiting the size object that can be viewed in detail. With smaller pixels, vegetative characteristics can be obtained from remotely sensed data and assist land managers in decision making.

METHODS

This study focused on the impacts of area estimation, using different imagery and interpreters, on forest management planning. Seven delineators were used to interpret stand boundaries from two different images of the same area. With this information, comparisons were made of the results to quantify the actual impact they had on a harvest schedule. The impacts found will help determine how much emphasis needs to be placed on delineation and imagery requirements. This research will also aid natural resource managers in decisions that determine the outcome of forest management practices.

In achieving the previously stated objectives, this study used information obtained from the NASA environmental office at the John C. Stennis Space Center. The Space Center is an area with a diverse coastal environment located on the Pearl River in Hancock County, Mississippi. This study used a 1,080 acre tract with different land and forest types. The tract is diverse in terms of tree species, stand density, land use, and topography. These characteristics were determined by aerial photographs, field observations, and consultations with the team leader of an inventory conducted on the site.

Color Infrared (CIR) photographs were obtained, along with Positive Systems® imagery, to use in the comparison. These images were obtained from the environmental office of NASA at the Space Center. The pixel resolution of the Positive Systems® imagery was 1 by 1 meter taken in the fall of 1998. The scanned aerial photographs had a resolution of 0.7 by 0.7 meters taken in the fall of 2000. The study site used for this research had not experienced any major harvesting activities between the dates of each image; therefore, image comparisons could be made without jeopardizing interpretation results (C. Case pers. commun., 2001). Students that had completed a course in forest photogrammetry in the Department of Forestry at Mississippi

State University were chosen for delineation duties. Interpretations of both images were then digitized using ERDAS Imagine software. CIR band combinations were used to help differentiate forest types on both images (i.e., hardwood and pine). Once all delineation's were completed, the acreages were determined using ArcView GIS.

A geographic information system (GIS) available for the area was assumed to be the true stand makeup for this study site. The original boundaries for this GIS were found using tax map information from Hancock County, MS. This GIS included several different timber types that had been determined previously from an inventory carried out at the Space Center. Since study delineations did not include information on stand types, other information had to be used for stand typing. The available GIS was used to assign stand types. Overlays of delineations and the GIS layer were done to assign correct stand types; however, when problems arose in determining which stand type to use, plot data for a specific area were used to assign the proper stand type. Plot data were generated from inventory information that had been entered into the GIS. Areas that did not have plot data available were compared visually to find similarities between spectral attributes of the questionable areas and then types were assigned accordingly.

Although field data from the Space Center were used in this study, landowner goals were hypothetical. WINYIELD 1.11 growth and yield software was used to determine an optimal management prescription that maximized land expectation value (LEV) (FRS 2002). Also, an optimal rotation age for mean annual increment (MAI) was determined to allow for more options in the decision making process. Discussions with the local area forester helped determine management strategies to be implemented in the area. Each prescription differed in some aspect from the others; however, all prescriptions were appropriate to the area. Costs associated with each prescription were obtained from Dubois et al. (2001). Costs included burning, herbicide use, and planting costs.

An LP model was run to determine which prescription was most desirable. LINDO was used to maximize the main objective and assist in determining the effect stand delineation had on harvest scheduling (LINDO 2001). The harvest schedule was for a planning horizon of 35 years with frequent activities occurring over the forest area as a whole. A basic example of the model is:

Objective Function

$$\text{MAX NPV} = \sum \alpha_{ij} X_{ij}$$

Decision Variables

X_{ij} = number of acres of stand i treated with prescription j

α_{ij} = NPV of stand i treated with prescription j

Constraints

$$\sum X_{ij} \leq \text{available acreage}$$

$$\sum \text{total revenue over 5-year period} \geq \$70,000$$

The hypothetical goal developed for the landowner was to maximize NPV. Net present values were found for each prescription using WINYIELD 1.11. Per-acre volumes were provided from 2000 inventory information to determine total volumes of certain stands. This information helped determine current stand conditions and the growth potential for certain areas.

Results obtained from this model were viewed as an optimal schedule of activities for the forest, given the specified objective function and constraints. The objective function value was the main criteria for evaluating the effect of area estimation on harvest schedules. Therefore, this value was examined to determine the amount of fluctuation possible when different interpreters or imagery was utilized.

RESULTS

There were differences in stand delineation between delineators, as well as between imagery types. Delineations were done by computer, where the scale of the photo was frequently changed making some stand characteristics easier to find than normal. Figure 1 demonstrates differences in stand delineation made by the same interpreter using different image types.

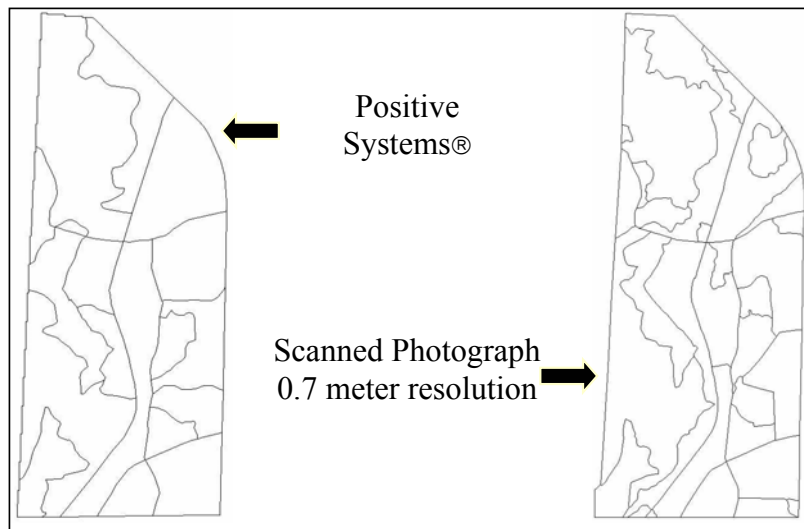


Figure 1. Example of delineations from different image types.

Throughout the delineation process, many polygons differed between interpreters and imagery. The variation of polygons in the delineation process suggested the amount of inconsistency that can be found in stand interpretation. These polygon differences were summarized in Table 1.

Table 1. Number of identified timber stands across interpreters and imagery, on the study area at the John C. Stennis Space Center.

Interpreter	Positive Systems®	Aerial Photo
1	30	21
2	16	27
3	24	26
4	33	25
5	26	22
6	31	33
7	24	20
Average	26	25
Minimum	16	20
Maximum	33	33

Prescriptions were written for each stand type which included all potential activities taking place during the 35-year planning horizon. Optimal prescriptions using LEVs and MAI were also found using Winyield 1.11 software. These prescriptions led to schedules for thinning operations as well as final harvests. Once optimal prescriptions were found, six different prescriptions were written for each stand type that included alternative management regimes.

A harvest scheduling model was run using each interpreter's stand type and acreage results by image. Each model determined the best prescription for maximizing NPV and produced acres allocated by prescription and associated costs, revenues, and wood flows. An overall OFV is determined for each interpreter's results. This value is the optimal NPV for managing the study area with the given constraints; however, results showed that the OFV changed as delineations or images changed (Table 2).

Table 2.Objective function values by interpreter and imagery on the study area at the John C. Stennis Space Center.

Interpreter	Imagery	
	Positive Systems® (\$)	Aerial Photo (\$)
1	2,277,420	1,729,663
2	1,636,718	1,880,735
3	1,594,490	1,687,620
4	2,074,342	1,530,457
5	1,502,128	1,517,227
6	1,870,560	1,884,127
7	1,602,161	1,376,052
Average	1,793,974	1,657,983
Minimum	1,502,128	1,376,052
Maximum	2,277,420	1,884,127

The harvest schedule was first determined using the acreage estimates from GIS. The OFV was \$1,906,451. This value was assumed to be the true value. For Positive System® imagery, OFV ranged from -21.2% to 19.5% of true value. For the scanned imagery, OFV ranged from -27.8% to -1.2% of true value. When all interpretations for each image were averaged, the Positive Systems® image had an average OFV difference of -5.9% and the scanned image had an average OFV change of -13.03%.

A 95% confidence interval was computed for each image to see if the true OFV was included. The standard deviation for the Positive Systems® imagery was \$290,023.36. The confidence interval was \$1,525,748 to \$2,062,200. The standard deviation for the scanned image was \$192,499. The confidence interval was \$1,479,952 to 1,836,014.

Using \$1,906,451 as the true value, a hypothesis test was conducted to see if the image values differed significantly from the true value. The alpha level was 0.05 with 6 degrees of freedom. For both images, the rejection region for the t-statistic was +/- 2.4469. Positive Systems® imagery had a t-statistic of -1.0261, which failed to reject the null hypothesis of $H_0: \mu = \$1,906,451$. Therefore, the Positive Systems® results were not significantly different from the true results at a 95% level of confidence. The scanned imagery had a t-statistic of -3.4150, which rejected the null hypothesis. Therefore, the scanned image results were significantly different from the true results at a 95% level of confidence.

DISCUSSION AND CONCLUSIONS

This study compared the use of different imagery for stand delineation and its associated impacts on area estimation and harvest scheduling. Also examined was the stand interpreter error on the delineation process. These objectives were accomplished by utilizing a linear programming model for optimization of net present value. Imagery and interpreters played an important role in the outcome of a harvest schedule.

The primary concern in forest management planning is the landowner's objectives. In this study, the landowner was NASA at the Stennis Space Center. NASA has timber management as its primary goal. Net present value was chosen for this objective because many landowners want to maximize the net worth of their investments. Other maximization values could have been chosen to see how they affected the harvest schedule; however, this study focused on maximization of net present value.

Delineation results show that there are important differences in stand interpretations between imagery and interpreters. Interpreter skill level may have an important impact on stand delineation. As previously mentioned, one interpreter indicated that one area on an image contained three different stand types and another interpreter identified only one stand type. No contributing factor influencing number of stands delineated could be consistently identified. Results could also be dramatically different between imagery. Logically, the number of timber stands found should be higher on the image with higher resolution because of the amount of detail portrayed. However, this theory was not demonstrated in the results. In higher resolution imagery, the number of timber stands identified was frequently less than on the lower resolution imagery, due to interpreter error.

The harvest scheduling model developed for this study included all prescriptions and their associated values. This model was constrained by acreage and budget constraints. Acreage constraints were the main focus since they were directly affected by delineation results. The model was written with all other values remaining constant except for the acreage estimates by stand type. This accomplished one of the main study objectives by strictly showing how acreage estimates affected harvest schedules. The results indicated that acreage estimates definitely were a major factor in determining the value of a harvest schedule. However, the contributing factor to the acreage estimation error did not consistently identify imagery or interpreters as the determining factor. OFV ranged from \$1.5 to \$2.3 million for Positive Systems® imagery and \$1.4 to \$1.9 million for the scanned image. The average OFV's for each image seemed to imply that the imagery was not a major source of variation in the OFV. However, when confidence intervals and hypothesis tests were conducted, they showed that Positive Systems® imagery results did not differ significantly, at a 95% level of confidence, from the true OFV, whereas the results of the scanned imagery were significantly different from the true OFV, at a 95% level of confidence. These tests imply that the image attributes did play a major role in the accuracy of the OFV.

FUTURE RESEARCH

With the many advancements in high quality imagery, future research could determine the effects of drastically different image resolutions on harvest schedules. Since this research only looked at 0.7 and 1 meter image resolutions, another project could be organized to determine the lower threshold image resolution that would still improve the accuracy of interpretations.

There are several software advancements (i.e., eCognition) that are utilizing an automated style of stand delineation and inventory analysis. These technical improvements in forestry will greatly change the way forests are managed when compared to current practices. For instance, companies have constructed programs that will identify all trees in a specific area. With this kind of information, individual tree values can be used with common correlations (i.e., live crown ratio) to determine many factors used in management planning. Of these factors, stand delineation can be done automatically with the proper tools. Therefore, it could be possible to

determine what effect these innovations will have on acreage estimation in the future. Research conducted on this new technology could be similar to the research conducted in this study; however, alternative methods for stand determination would be used.

There are many aspects that cause differences in forest management strategy; however, there will always be some sort of error present in any modeling or estimation process. Forest management is moving to more efficient management technologies. With this change, there will always be factors that need to be addressed to determine if current practices are enhancing the future of the forestry profession.

ACKNOWLEDGMENTS

Hugh V. Carr, Craig Case, Emily B. Schultz, and Deborah A. Gaddis

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Incorporating Interstate Trade In a Multi-region Timber Inventory Projection System

Lawrence Teeter, Maksym Polyakov and Xiaoping Zhou

Abstract: An interregional trading model for stumpage products was developed that recognizes the importance of demand centers (centers of forest products manufacturing activity) and inventory in forecasting future harvests and trade flows. A gravity model was constructed that considers the relative position of each region vis-a-vis all others as a producer of stumpage and as a consumer of stumpage products. The gravity model was incorporated in a multi-region version of DPSupply referred to as the Interregional DPSupply System (IDPS). Projections for growth, harvest and trade in forest products were made for the thirteen state southern region through 2025. Aggregate trends in inventory are similar to those reported in the Southern Forest Resource Assessment. Inventory trends by product (pulpwood, sawtimber) and type (hardwood, softwood) differ by state and are used to illustrate the advantages of explicitly recognizing interregional trade in the projection system.

Key Words: supply, demand, modeling, FIA data, harvest

INTRODUCTION

The South is the major timber production region in the United States. In 1997, nearly 58% of US industrial roundwood and three-fourths of total US pulpwood production was produced in the region (USDA Forest Service 1999). A number of projections made in the 1970s and 1980s predicted an increasing share for the US South both in timber growth and removals (Haynes and Adams 1985).

The objective of this project was to develop an interregional trading model for stumpage products that recognizes the importance of demand centers (centers of forest products manufacturing activity) and inventory in forecasting future harvests and trade flows. The model adapted work done by Teeter and others (1989) who modeled interindustry trade and highlighted the interdependence of producing regions. In line with that work, a gravity model was constructed that considers the relative position of each region vis-à-vis all others as a producer of stumpage and as a consumer of stumpage products. As a result, the model allows for changes in the harvest levels among regions to accommodate imbalances in inventory, changes in production capacity, and transportation costs from the source of the raw material to manufacturing facilities.

Multiregional input-output models

As an economy develops, goods produced in one region are often sold in another region of the country. Several groups of methods exist for regional interdependence analysis. One group includes fixed trade coefficient models (multiregional input-output models), and another includes linear programming models.

Fixed trade coefficient models are based on the following principle: the total output of interindustry demands (including the industry itself) and demands by final users equal the industry's output. While linear programming models require a large number of parameters to support the analytical mechanisms of interregional trade, fixed trade coefficient models utilize empirical trade relationships between industries and regions themselves. These models were developed by (Leontief 1963, Polenske 1970, and Bon 1984) and were designed as rough and ready working tools capable of making effective use of limited amounts of factual information. In forest economics these models were used by (Teeter et al. 1989).

Interregional trade is accounted for using one of three models within the fixed trade coefficient framework: a column coefficient model, row coefficient model, or gravity coefficient model. Due to space limitations, only the gravity coefficient model will be described here.

According to the gravity coefficient model, the amount of good i shipped from region g to h is:

$$X_{gh}^i = \frac{X_{go}^i X_{oh}^i}{X_{oo}^i} \hat{Q}_{gh}^i \quad \forall \quad i, g, h$$

where:

i, g, h – product, production and consumption regions

x_{gh}^i – amount of product i shipped from region g to h

X_{oh}^i – amount of product i shipped to region h

X_{oo}^i – total amount of commodity i produced in an economy;

\hat{Q}_{gh}^i – gravity coefficient, determined as:

$$\hat{Q}_{gh}^i = \frac{X_{gh}^i X_{oo}^i}{X_{go}^i X_{oh}^i}$$

This method expresses the assumption that the shipments of commodity i from region g to region h are proportional to the total production and total consumption of commodity i in the two regions, respectively, and are inversely proportional to the total amount of commodity i produced in all regions (Bon 1984).

Leontief and Strout (1963) developed four methods to derive gravity coefficients: the exact solution, a point estimate solution, a least squares solution and the simple solution. Details describing each of these methods can be found in Leontief (1963) or Teeter et al. (1989). Due to the availability of initial period data on interstate trade, this study implemented an exact solution to determining gravity coefficients.

DATA

Development of an interregional DP Supply model for the US South and performing simulations requires the following data:

- Forest Inventory Analysis (FIA) inventory data by sample plot for each of 13 states. The data were obtained from the USDA Forest Service website and included the following inventories: Alabama-2000, Arkansas-1995, Florida-1995, Georgia-1997, Kentucky-1988, Louisiana-1991, Mississippi-1994, North Carolina-1990, Oklahoma-1993, South Carolina-1993, Tennessee-1999, Texas-1992, and Virginia-1992.
- Timber Product Output (TPO) data on production, consumption and trade of major timber products for each of the US South states. The data were obtained from bulletins of the USDA Forest Service Southern Research Station, for example, (Johnson and Steppleton 2001, Bentley et al. 2002, Johnson and Brown 2002) and from the TPO website.
- Stumpage price data collected by Timber Mart-South.

METHODS

Modeling future trading activity in forest products

The availability of data on the production, consumption and trade of forest products between US Southern states allows us to use the exact solution method to determine base year gravity coefficients. However, direct application of the method would not allow us to model the trade dynamics resulting from changes in timber inventories of producing states.

The gravity coefficient method assumes that shipments of commodity i from region g to region h are proportional to the total production and total consumption of commodity i in the two regions, respectively, and are inversely proportional to the total amount of commodity i produced in all regions. To adapt the basic model to accommodate the dynamics of inventory growth, it is reasonable to assume that the shipments of wood product i from region g to region h are also proportional to the amount of wood available to harvest in region g . Now the amount of timber product traded will be:

$$X_{gh}^i = \frac{X_{oh}^i I_g^i}{X_{oo}^i} \hat{Q}_{gh}^i$$

and the ‘modified’ gravity coefficient will be:

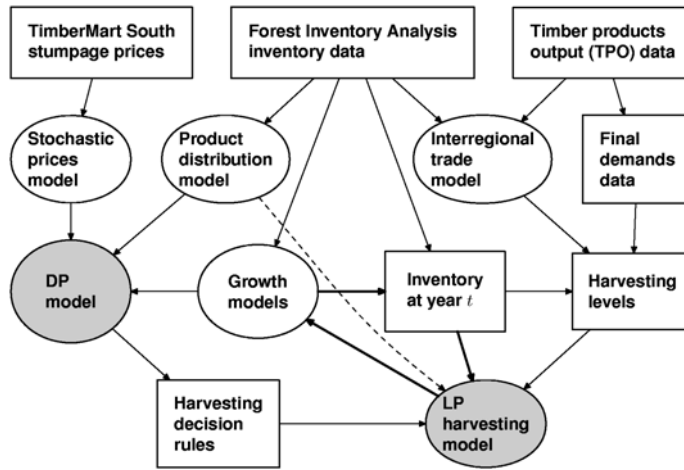
$$\hat{Q}_{gh}^i = \frac{X_{oo}^i}{X_{oh}^i I_g^i} X_{gh}^i$$

where:

g – supply region;

h – demand region;

I_g^i – amount of timber product i available in supply region g .



Assuming that the ‘modified’ gravity coefficients remain stable, the goal is to determine regional demands, and amounts of wood available for harvesting, harvest levels and trading levels in each forest product for future periods through 2025.

Figure 1. Interregional DP/Supply system

An interregional DP/Supply model with stochastic prices

At the core of the Interregional DP/Supply (IDPS) model are two main modules: a dynamic programming (DP) model for determining optimal harvesting decisions, and a linear programming (LP) harvesting model (see Figure 1). Both models depend on several auxiliary models, including growth models, product distribution models, and information on area transition probabilities to account for changes in forest area by type over time. Extending DP/Supply (Teeter 1994, Teeter and Zhou 1996, Zhou 1998) to incorporate the 13-state southern region requires accounting for regional differences in growth, the anticipated products from stands and area change. To accomplish this goal, the region was delineated according to physiographic regions (five) similar to those identified by Bailey (1995) and included the coastal plain, the piedmont and mid-coastal plain, the mountains and interior plateaus, the Mississippi alluvial basin and the western piedmont and mid-coastal plain regions. Using the FIA data from the counties in each region, growth models were constructed for each of 5 key forest management types: Planted Pine, Natural Pine, Oak-Pine, Lowland Hardwood and Upland Hardwood for each of the physiographic regions by owner class using methods similar to those used in earlier applications of the DP/Supply model. Product distribution models to allocate the

projected volumes on each plot to each potential product class were constructed for each physiographic region following methods outlined by Teeter and Zhou (1999).

Area Change

Area change in the projection system has 3 integrated components:

- 1) acres gained by each of forest management type from non-timberland
- 2) acres lost by each forest management type to non-timber land
- 3) acres lost by one management type through transition to another management type

In order to model 1 and 2, all FIA plots were selected which had non-timber land as the previous land use type and one of five forest management types as the current land use type, or those having one of the five forest management types as the old land use type and non-timber land as the current land use type. These plots were grouped by forest inventory unit. For each forest inventory unit, net loss and net gain by forest management type were calculated. Based on the length of a unit's survey period, annual gain was calculated and future gain was modeled by annually adding the appropriate proportion of acres to each forest management type by FIA unit. Net loss was modeled by adjusting (decreasing) the area of timberland annually. This method is similar to the method reported by Zhou and others (2003) that uses historical FIA data.

To model transitions between forest management types, all FIA plots where harvesting took place during the survey period were selected. The probability of transition was modeled using a multinomial logit model. The probability that a new (current) forest management type would be a particular type was assumed to be a function of the old (previous survey) forest management type and the ownership class associated with the plot. Transition probabilities were calculated for each forest management type by physiographic region. During simulation, each harvested plot was partitioned into several new plots of different management types depending on the plot's pre-harvest forest management type and ownership class, with new plot areas determined proportionally according to the values of the transition probabilities.

Harvest Decisions

The assumption of the dynamic programming component of the IDPS model is that forest owners manage their forests in order to maximize net present value over an infinite series of rotations. Although the importance of this objective for NIPF owners has often been questioned, work by Newman and Wear (1993) supports the basic assumption. Another assumption of IDPS is that forest owners bear replanting costs at the beginning of the rotation and receive income when thinning occurs or at the end of the rotation, when they sell stumpage. Because replanting is assumed only for pine plantations, for all other forest types income at final harvest is the only component of cash flow.

The general recursive equation for the dynamic model can be expressed as:

$$V_t = \underset{k}{\text{Max}} [\pi (P_t, o_t, s_t, d_t, u_t, k_t) + \beta \underset{P_{t+1}}{\text{E}} V_{t+1}(P_{t+1}, o_{t+1}, s_{t+1}, d_{t+1}, u_{t+1})]$$

$$\forall o_i, s_j \quad i = 1, 2; j = 1, \dots, 5$$

Where: k_t --- cut decision at time t ;
 d_t --- dbh class at time t ;
 u_t --- volume per acre at time t .
 P_t --- timber product price per cubic foot at time t
 o_i --- ownership -- non-industrial private or industry;
 s_j --- forest type – planted pine, natural pine, oak-pine, lowland or upland hardwood;
 π --- immediate net returns
 E --- a conditional expectations operator over random future prices P_{t+1}

Because prices change over time, the expectations for future prices influence forest owners' decisions about when to harvest. For this reason, a stochastic pricing element, similar to the one developed in (Teeter et al 1993), was incorporated in the IDPS model to produce more realistic outcomes, i.e., owners are more willing to offer timber for sale when the price is unusually high because of the expectation that it will fall in the future.

The IDPS LP harvesting module was modified to accommodate individual states and/or FIA units separately and interface with the interregional forest products trade model. For each year of the projection period, the volumes of timber products available for harvesting are generated using the initial inventory of a given year, a matrix of optimal harvesting decisions obtained from the dynamic program, and product distribution models derived from the region plot data. Harvest levels for each product in each state are determined using available inventory, final demands, and the interregional trade coefficients produced by the interregional trade model. The linear programming model then allocates the harvest request (demand) for each product in each state among the stands available for harvesting by choosing those stands which have an appropriate mix of products and can be harvested at the lowest price. Stands that are not harvested are then 'grown' one year using the growth models, resulting in the next year's initial inventory.

RESULTS

Inventories

We examined 3 different scenarios regarding future patterns of consumption (by firms) of wood products in the southern region using the IDPS model. These scenarios reflect trends similar to those examined by the 2000 RPA and the Southern Forest Resource Assessment including a) no change in the level of demand for forest products from its level in 2000, b) a 0.5% annual increase in demand for forest products and c) a 1% annual increase in demand. Only the 0.5% scenario is discussed below and will be referred to as the Base Case (it is considered the most likely scenario and is also close to the level of U.S. demand increase expected by Trømborg and others (2000).

Figure 2 illustrates inventory projections for the entire southern region. Total softwood inventory is projected to increase 26% between 2000 and 2025 with pulpwood inventories peaking in 2008 and ultimately declining about 7% from their 2000 levels. Softwood sawtimber is projected to increase throughout the projection period. Total hardwood inventories are projected to increase 23% with pulpwood inventories remaining stable after 2010 and sawtimber inventories increasing throughout the projection period.

On an individual state basis however, a much different future is projected in some cases. In Virginia and North Carolina, significant declines in softwood pulpwood inventories are projected (-34% and -22% respectively) for the Base Case. In North Carolina, hardwood pulpwood

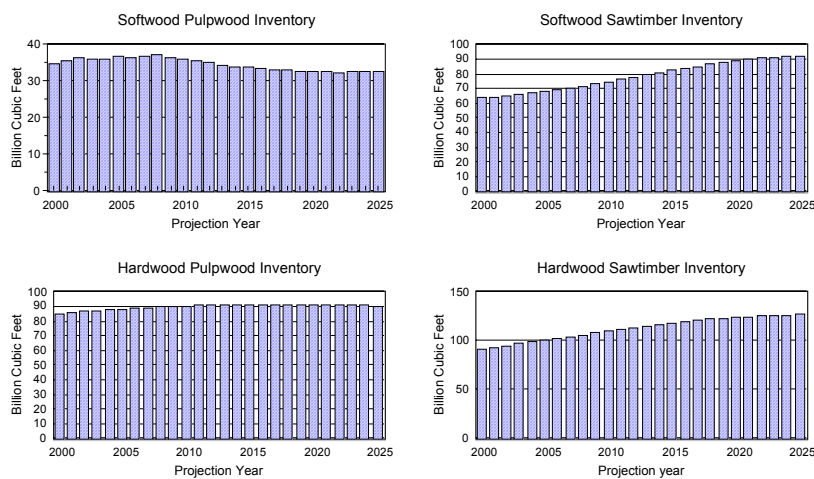


Figure 2. Inventory projections for the 13-state southern region – Base Case.

inventories are also projected to decline (Figure 3). In general, most states show large softwood sawtimber increases and are projected to have declining softwood pulpwood inventories under all scenarios. Hardwood pulpwood inventories are projected to increase 7% for the region under the Base Case scenario, but a number of states including Alabama, Georgia, Louisiana, North Carolina, South Carolina, and Virginia show projected declines of 7%-12%. Reductions in harvest levels during the projection period have allowed inventories to remain stable in some states.

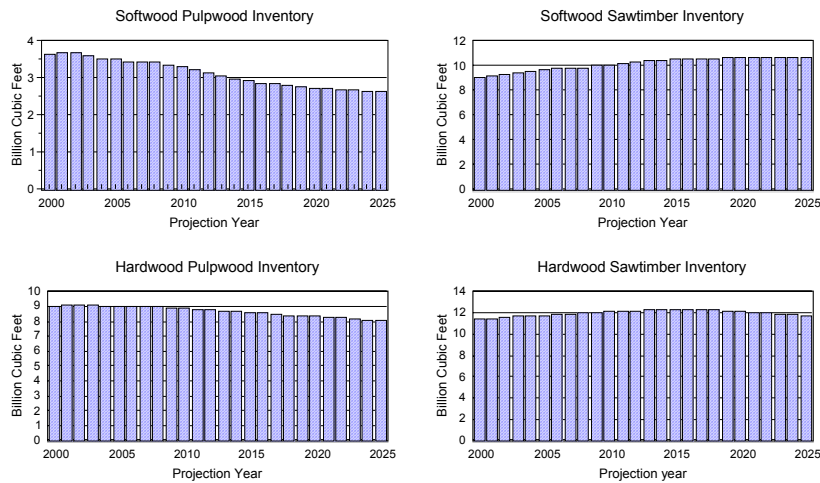


Figure 3. Inventory projections - North Carolina – Base Case.

Interregional Trade

A key feature of the model developed for this study revolves around acknowledging the role of interregional trade in meeting regional demand for softwood and hardwood products. As was mentioned previously, harvest levels in some states dropped over the projection period (Figure 4) while overall harvest for the region increased over the projection period and met the demand

levels for each state as they were represented by the scenarios. Trade among states allowed this to happen (see figures 5 and 6).

Figure 4. Relative changes in hardwood pulpwood harvest level by state – 2000-2025.

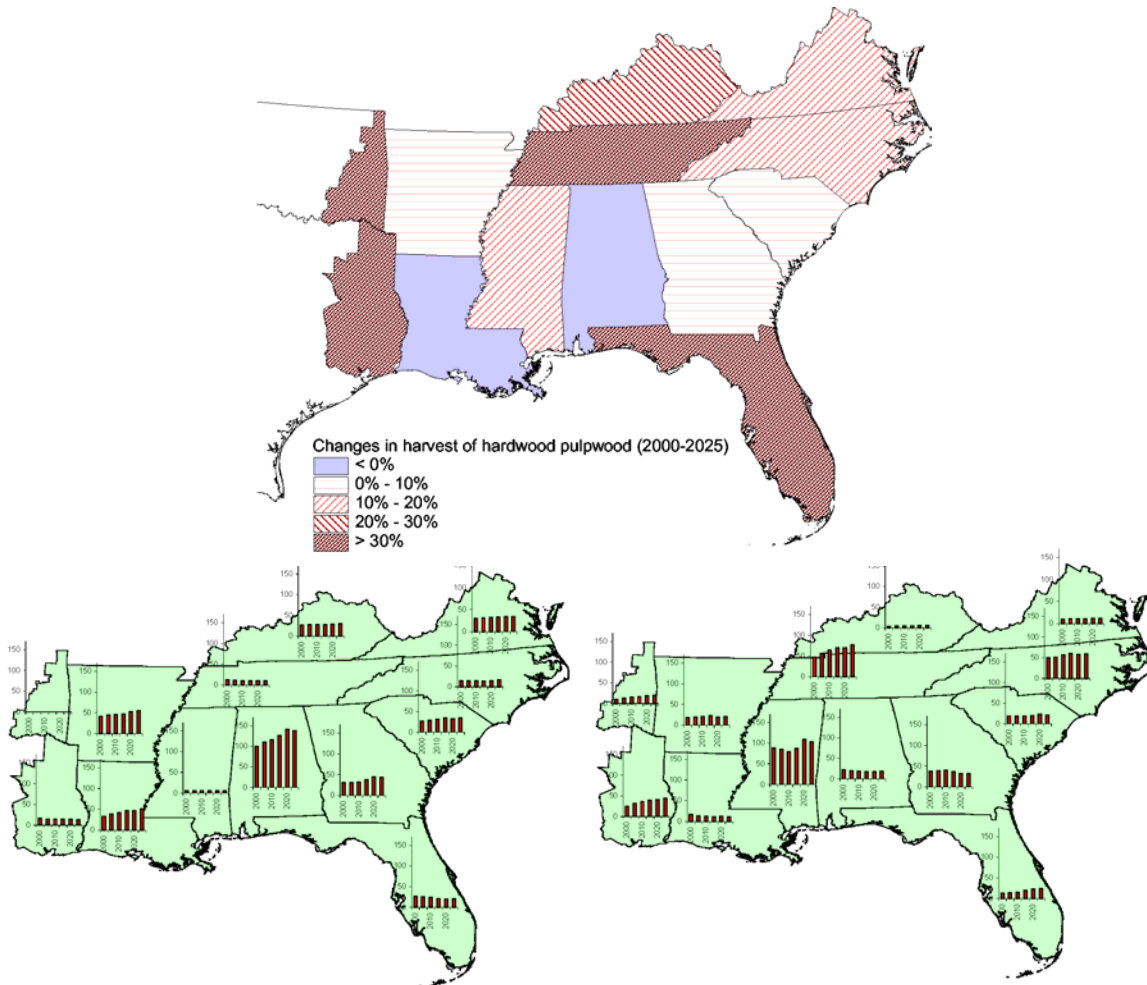


Illustration of how these effects interact in the simulation model are best understood by example. Consider Figure 11 and Figure 18 (below). Alabama and Louisiana (Figure 18) are projected to reduce hardwood pulpwood harvest levels over the projection period, while accommodating a 0.5% increase in demand in the Base Case. In Figure 18 we see that this is accomplished by increasing imports of hardwood pulpwood in each state. No state that is projected to increase

hardwood pulpwood harvest levels substantially is also projected to increase its imports of the product. A similar connection between Figure 11 and Figure 19 can also be made. As hardwood pulpwood harvest levels are projected to increase in several states, (eg., Florida., Tennessee, East Texas, Oklahoma, North Carolina) the exports of the product from those states will increase to help meet demands in other states.

Figure 5. Dynamics of hardwood pulpwood state-level imports, 2000-2025, Base Scenario, MCF

Figure 6. Dynamics of hardwood pulpwood state-level exports, 2000-2025, Base Scenario, MCF

Trade matrices are recalculated for each year of the simulation to account for changes in the relative ability of states to produce timber over and above the regional (state level) demand. For example, a state that has 100,000 acres available for harvest above those necessary to meet regional demand would be relatively more likely to export to a state needing the product than another state that only has 50,000 acres available above its regional demand. Acres available means they meet the economic test of financial maturity. States with relatively more “surplus” available acres are more likely to be large exporters in a given period. States with a wider gap between the amount of a product available for harvest and its regional demand will likely be a relatively larger importer of the product in any given year. Distance is also a factor in establishing trading relationships with other states and that is evidenced in the trading tables. Most states trade with neighboring states and possibly one or two others. Figure 7 illustrates trading relationships embedded in the model for hardwood pulpwood. Georgia has export relationships with seven other regions (including Rest-of-the-World – oo) and imports from four. Tennessee imports hardwood pulpwood from seven states and exports to six. These trading relationships are important for understanding the dynamics of inventory growth and removals throughout the region and the ability of those relationships to help industries meet regional demands.

Dynamics of Hardwood Pulpwood Trade															
Million Cubic Feet															
2000	To														
From	AL	AR	FL	GA	KY	LA	MS	NC	OK	SC	TN	TX	VA	OO	Total
AL	196.6		14.2	5			0.7	0.1			2.6				219.2
AR	0	60.4				5.4	0.6					12			78.4
FL	1.5		27.3	10.8			0			0					39.6
GA	13.1		12.4	117.9	2.8		0	1.1		0.5	4.7		0	2.8	155.3
KY	0.6				12.4			0		0.2	0.6			2.5	16.3
LA	0	8.5				70.1	4.1			0		4.7			87.4
MS	59.1	6.6	0.1			20.6	61.8	0.1			1.6				149.9
NC				0	4.3			53.1		25.4	0.3		15.5	4.3	102.9
OK		9.4							5			0.1			14.5
SC				14.9				4.5		62.9					82.3
TN	25.7			0.1	16.3		0	5.3		0	24.3		0.1	0.1	71.9
TX		16.7				7.6						21.3			45.6
VA								2.8		0.4	1.2		77.5	5.5	87.4
OO					3.4			0		0.2	1.2		14.8		19.6
Total	296.6	101.6	54	148.7	39.2	103.7	67.2	67	5	89.6	36.5	38.1	107.9	15.2	1170.3
2025	To														
From	AL	AR	FL	GA	KY	LA	MS	NC	OK	SC	TN	TX	VA	OO	Total
AL	197.5		11.2	5.3			0.7	0.1			1.8				216.6
AR	0.0	60.0				8.8	0.9					10.8			80.5
FL	2.9		40.1	21.0			0.0			0.0					64.0
GA	13.3		9.9	124.5	1.9		0.0	0.9		0.5	3.3		0.0	2.3	156.6
KY	1.1				15.0			0.1		0.4	0.7			3.7	21.0
LA	0.0	4.9				66.0	3.8			0.0		2.5			77.2
MS	73.6	4.7	0.1			23.7	70.7	0.1			1.4				174.3
NC				0.1	3.9			59.4		32.8	0.3		17.0	4.8	118.3
OK		19.9							5.6			0.3			25.8
SC				17.5				4.1		67.0					88.6
TN	47.7			0.1	20.2		0.1	8.0		0.0	31.4		0.1	0.1	107.7
TX		25.6				18.9						29.6			74.1
VA								3.2		0.6	1.2		87.4	6.4	98.8
OO					3.4			0.1		0.3	1.3		17.8		22.9
Total	336.1	115.1	61.3	168.5	44.4	117.4	76.2	76.0	5.6	101.6	41.4	43.2	122.3	17.3	1326.4

Figure 7. Example trade matrices for three selected years for hardwood pulpwood, 2000, 2015 and 2025.

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Native Americans and Montana Residents Willingness-to-pay for Fire Prevention Programs

Armando González-Cabán, John B. Loomis, Hayley Hesseln, USDA Forest Service and Colorado State University

Abstract: We compared survey response rates, protest responses, and willingness-to-pay for two forest fire prevention programs for Montana residents and members of two tribes in Montana. The prescribed burning and mechanical fuels reduction program information was mailed to participants prior to an in-depth phone interview. The first contact phone interview showed basically no difference between Native Americans and other Montana residents, but the rate for the in-depth follow up interview with Native Americans fell sharply. There was no statistically significant difference in the protest response rate for the prescribed burning program between Native Americans (7%) and Montana residents (9.6%). The protest response rate for the mechanical program was much higher for both groups at 22% for Native Americans and 32% for Montana residents; and statistically significantly different at the 0.05 level. The logit willingness-to-pay regression coefficients of the Native American and Montana general populations were statistically different for the prescribed burning at the 0.01 level, and the 0.05 level for the mechanical fuels reduction program. Native Americans mean willingness-to-pay for prescribed burning and mechanical fuels reduction was nearly twice that of Montana residents. However, the large variance around the Native American mean WTP estimates suggests the differences between the two groups is not statistically significant. Willingness-to-pay for the prescribed fire program was 50% higher and the protest rate about one-third lower than for the mechanical fuels reduction program.

Optimizing Fuels Management for Wildfire Risk Reduction in Florida

Evan Mercer, Jeff Prestemon, David Butry, John Pye, Tom Holmes, Karen Abt, Economics of Forest Protection and Management Work Unit, Southern Research Station, USDA Forest Service

Abstract: Wildfires in the United States result in total damages and costs that are likely to exceed billions of dollars annually. Land managers and policy makers propose higher rates of prescribed burning and other kinds of vegetation management to reduce amounts of wildfire and the risks of catastrophic losses. A wildfire public welfare maximization function, using a wildfire production function estimated using a time series model of a panel of Florida counties, is employed to simulate the publicly optimal level of prescribed burning in an example county in Florida (Volusia). Evaluation of the production function reveals that prescribed fire is not associated with reduced catastrophic wildfire risks in Volusia County Florida, indicating a short-run elasticity of -0.16 and a long-run elasticity of wildfire with respect to prescribed fire of -0.07. Stochastic dominance is used to evaluate the optimal amount of prescribed fire most likely to maximize a measure of public welfare. Results of that analysis reveal that the optimal amount of annual prescribed fire is about 3 percent (9,000 acres/year) of the total forest area, which is very close to the actual average amount of prescribed burning (12,700 acres/year) between 1994-99.

Cost Function Estimates for Large Fires

Karen L. Abt, Robert J. Huggett, and Jeffrey P. Prestemon, Southern Research Station, USDA
Forest Service

Abstract: Recent extreme fire seasons (1998, 2000, and 2002) combined with overall increasing costs led to fire suppression expenditures exceeding \$1 billion per year. As a result, the costs of fire suppression, in particular for large fires (>1000 acres) and siege fires (>14 days), have become an issue of concern both for the federal and state governments who incur most of these costs. Using fire level occurrence, suppression resource, and cost data for 2000, we estimate a cost function for wildfire production (acres burned) using inputs of labor, aircraft and other good and services. Quasi-fixed factors of production include month of fire, ecological factors (elevation, fuel type, drought index). Results show (? I hope ?) the level of tradeoffs between the inputs and estimates shadow values for the quasi-fixed factors. These tradeoffs will assist fire managers in determining cost-effective suppression strategies.

Decision Methods for Forest Resource Management

Joseph Buongiorno and J. K. Gilles, University of Minnesota

Abstract: This presentation will discuss teaching and learning forest resource management methods, for senior undergraduates, first year graduate students, and professionals in forestry, natural resource management, as well as other fields of environmental science. It will review some key methods of scientific forest management. Simple models dealing with the ecological and economic impact of alternative management decisions, in even-aged and uneven-aged forests will be discussed. The relevant decision methods will be presented with spreadsheet models, using a variety of examples.

Trees in The Residential Landscape: A Hedonic Study Of Property Valuation

Tymur Sydor¹, David H. Newman¹, J.M. Bowker², H. Ken Cordell²

¹- Warnell School of Forest Resources, University of Georgia; ²- USDA Forest Service, Southern Research Station, Athens, Georgia

Abstract. A hedonic price model for determining the implicit effect of trees on the value of residential property was estimated for Clarke County in Georgia. A linear, semi-log hedonic price model was utilized to estimate the implicit marginal prices of absolute percentage changes in leaf cover on a property from the selling price of residential property. Significant independent variables included the size of the property, total heated area of the house, year of sale, market price of parcel, and leaf cover on property. Results show that the presence of trees, as measured by leaf cover, and a neighborhood effect provide significant positive premium to the overall value of the property.

Keywords: hedonic, tree value, residential property, implicit value.

Preliminary Study on the Effects of Transportation on Forest Management and Production Forestry in Mississippi¹

D. Paul Gilliland², Donald L. Grebner, William Stuart, and Laura Grace

Abstract: The transportation system and overall infrastructure of a state is an important element in sustaining economic activity. In Mississippi, the forest products industry accounts for a significant portion of the economy. In 1997, more than \$1.3 billion dollars worth of timber was harvested in Mississippi (Daniels, 2000). Without an efficient transportation network, the cost to procure raw material to these mills would be extremely high and the margin of profit low. There are many factors that control a logger's transportation costs, which account for about 40% of total operating costs (Shaffer and Stuart, 1987). The purpose of this study is to examine the transportation of roundwood in three counties of Mississippi (Alcorn, Oktibbeha, and Wayne) and determine whether different regulations and roads affect wood hauling costs, therefore reducing the quantity of utilized wood by diminishing forest management opportunities. Comparisons with adjacent states will be conducted. This study utilizes a residual value approach for assessing policy impacts on hauling costs. Preliminary results are presented.

Funding: Mississippi State University, Department of Forestry and the USDA Wood Utilization Research Grant

¹Approved for publication as Journal Article No. FO 240 at the Forest and Wildlife Research Center, Mississippi State University.

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INTRODUCTION

The forest products industry is an important sector of the economy in the southern United States. Private non-industrial landowners own the majority of the forestland in the region, and depend on a viable market for products to support their investment. Timber is the second most valuable agricultural crop in Mississippi. Timber was the number one agricultural crop in 49 of Mississippi's 82 counties in 1997, and the number two crop in 17 counties (Daniels, 2000). According to Daniels (2000), it had a delivered value in excess of \$1.3 billion. Timber values in the counties where it was the number one crop ranged from \$5 million to \$39.2 million dollars. The total value Mississippi landowners received for their timber in 1997 was \$1.02 billion (Daniels, 2000). When looking at the value of timber in Mississippi, however, it is important to look at the total economic picture.

The transportation system is an important component in a state or region's economy. In the forest sector, logs are transported to a mill or wood-yard by trucks on roads of all standards, from simple woods roads to interstate highways. Without an efficient transportation network, the cost to acquire raw materials would be high, reducing the competitiveness of Mississippi's timber in what is now a global market. There are many factors that affect a logger's transportation costs, which account for about 40% (Shaffer and Stuart, 1987) of total harvest and delivery costs. Factors such as road quality, road and bridge weight limits, taxes, insurance, etc., affect the cost of transporting wood. These costs are passed along to the landowner, resulting in lower prices for their timber. These increased costs are also taking their toll on logging contractors. Texas reported a loss of 40 – 45% of their logging contractors due to increasing expenses such as insurance, fuel, workers compensation, etc. (Anon, 2001). Mississippi's losses are similar to these.

The objectives of this study are to: 1) develop a cost profile for hauling logs, 2) evaluate potential road weight limit proposals for three counties in Mississippi. Alcorn, Oktibbeha, and Wayne counties were chosen for this study because of their location and local proposals to lower road weight limits on county roads. Alcorn County borders Tennessee and proposed a 40,000-pound road weight limit. Oktibbeha county is only one county west of Alabama; supervisors proposed a 57,650-pound road weight limit. Wayne County borders Alabama and proposed a 57,650-pound road weight limit. This study utilizes a residual value approach for assessing policy impacts on hauling costs.

Development of Transportation Systems

The value of good roads has been recognized since Roman times. The Romans had three classes of roads: public, military, and private. Public roads were the most important. These were used by merchants and farmers to transport goods to the market place. Land travel in those times was much safer than traveling over water because of pirates and storms. Military roads were second in importance. These were primarily used by the military in times of war to transport troops, equipment, and supplies in a quick and efficient manner. When the military was not using these roads, they were opened to public use. Lastly, there were the private roads. These roads were constructed and maintained by private individuals who charged a fee or "toll" for travelers to use. The Romans understood that an efficient road system was essential in maintaining economic activity and in the defense of the country. Our interstate system, built with national defense in mind, is essentially a military road with public use permitted. The

federal and state road system evolved to serve inter-urban commerce and the county or “farm to market” roads were constructed to transport supplies to market towns and for personal uses.

Although good roads were desired in the earliest settlement days of the U.S., demand increased even more when rural free delivery was introduced in the late 1800s. Good roads were needed so that postal workers could get deliveries to rural households. Farmers required better roads for transporting crops to market. In addition, one of the greatest impacts on the development of United States roads was the introduction of Henry Ford’s Model T in 1908. This automobile was affordable by many households. In the early 1900s, the number of automobile owners grew rapidly and so did the demand for better roads. In 1910, there were 458,000 registered automobile owners in the United States. By 1915, there were 2.3 million automobiles and 8.1 million just five years later (Kuennen, 2002). President Wilson signed the Federal Aid Road Act in 1916. This legislation allocated funds to state highway agencies for highway construction and improvements.

The Natchez Trace is one of the most famous roads in Mississippi, serving foot travelers and post riders. It ran from Nashville, Tennessee to Natchez, Mississippi. The Robinson Road was constructed in 1821 to transport cotton and other goods. It connected Columbus, Mississippi (located in the heart of the black prairie cotton region) with Jackson, Mississippi, two of the largest cities in Mississippi at that time. The Jackson Military Road was built in the 1820s to link Nashville, Tennessee to New Orleans. This road’s purpose was to allow defense of New Orleans in case of an attack from the Gulf of Mexico. The first concrete road in the South was constructed in Lee County in 1915. During the mid – 1800s railroad companies began to move into Mississippi in order to service the lumber industry and soon became the major source of transporting goods. Prior to the railroad, water transportation was the only means of shipping large quantities of goods in Mississippi. In 1987, the Mississippi legislature passed the Four Lane Program. This program added 1,077 miles of four lane highways to the existing highway system. Over \$5 billion will be spent over three phases to complete the project, which is currently about one-third complete (www.peer.state.ms.us, 2003).

Mississippi is different from many other states in the fact that it has a three-tiered road system with federally funded roads, state funded roads, and county funded roads. County funded roads account for about 85% of the total road mileage; the other 15% are state and federally funded. According to Mississippi state code, §65-9-1, the board of supervisors has full jurisdiction over all roads, ferries, and bridges in their respective county not maintained as state highways. These roads are designated as “feeder”, “local farm roads”, or “state aid roads”.

County Profiles

Alcorn County is located in northeast Mississippi and borders Tennessee, a state with a maximum gross vehicle weight of 88,000 pounds. The Alcorn county board of supervisors proposed a 40,000-pound road weight limit to help reduce maintenance costs on county roads. Fifty-four percent of land in the county is forested. The major forest type is oak-hickory followed by planted pine. All of the land in Alcorn County is privately owned. Forestry is the number one agricultural product followed by cattle and corn (Traugott, 2001).

Oktibbeha County is located in east central Mississippi and is one county west of Alabama. The Oktibbeha county board of supervisors proposed a 57,650-pound road weight limit. Sixty-four percent of the total acreage is forested. Of that 64% forested land, the major forest type is oak-hickory followed by native pine. Approximately 79% of the land in Oktibbeha

County is privately owned. Forestry is the number one agricultural product followed by milk and cattle (Traugott, 2001).

Wayne County is located in southeast Mississippi and borders Alabama, a state with a maximum gross vehicle weight of 88,000 pounds. The Wayne county board of supervisors proposed a 57,650-pound road weight limit. Eighty-six percent of the total acreage is forested. The major forest type is native pine followed by oak-pine. Less than half of the land in Wayne County is privately owned. Forestry is the number two agricultural product with poultry being number one (Traugott, 1999).

Data was collected from the Office of State Aid Road Construction on bridge conditions in each of the three study counties. According to Table 1, Oktibbeha had the best bridges. Only 8% of 160 bridges were damaged (unable to carry the weight of an 84,000 pound truck). Out of 157 bridges in Alcorn county, 28% were damaged and in Wayne county, 15% of 159 bridges were damaged. Supervisors may, in effect, set two different weight limits for a stretch of road, one to protect the road itself and another because of

Table 1. Condition of Bridges in the Three Study Counties.

County	Deficient	Critical	Closed	Total w/damage	Total Bridges	Percent Damaged
Alcorn	43	2	3	44	157	28%
Oktibbeha	13	12	0	13	160	8%
Wayne	12	21	2	24	159	15%

the condition of bridges along that road. Mississippi has had a major initiative to replace lower-weight wooden and metal bridges with concrete, box culvert bridges of higher standards in recent years, but replacement has not been completed. A bridge with “deficient” structural components is one with rotten or cracked piles, spalled concrete, severely rusted members, joint misalignment, broken welds, etc. If a bridge is rated “closed”, then the structure is unable to carry at least 6,000 pounds. “Critical” maintenance means that the structure is in need of immediate attention in order to remain in service. Lack of attention could lead to a reduction in safe load capacity below 6,000 pounds.

Transportation Costs

There are three main areas that affect transportation costs: infrastructure, policy, and equipment. Road and bridge standards are very important for efficient transportation, as is road width, alignment, and pavement. It is also important to look at conditions of the roads and bridges in the area. What is the shortest route to the main highway with bridges that will support a heavy load? A second issue is the number of other uses along a route. The number of other users (i.e. farm trucks, gravel trucks, oil trucks) increases the possibility of complaints about dust, noise, danger, etc. Policy also affects transportation efficiency. Policy such as weight limits set by state and local governments on roads and bridges limit the normal operating practices of logging contractors, increasing their costs. Labor costs are probably the most important expenditure of a logging contractor. There are, however, other components such as equipment, insurance, fuel, and maintenance that are directly linked to equipment costs. According to this study, it costs a logger 12¢ per mile to haul one ton of roundwood. This estimate does not include an ad valorem tax of about \$4,000/year on the log truck.

METHODS

This paper focuses on how lower road weight limits can affect the price a landowner receives for his standing timber. The first objective will be achieved by profiling the cost expenditures associated with hauling wood and deriving cost per mile assuming a 25-ton load with speed of about 50 miles per hour. This is the “unregulated” situation and will serve as a control condition. The same will be done assuming a 13.5-ton load and a 5-ton load to reflect changes in the road weight limit policies. A truck can carry 13.5 tons with a 57,650-pound road weight limit and 5 tons with a 40,000-pound road weight limit.

The second objective is to utilize a conceptual residual value model that reflects changes in transportation policies that directly impact wood hauling costs. The model will be adjusted for each county by using regional average cost values. Stumpage price data collected from Timber Mart South, Inc. will be used to evaluate relative changes in costs and their effect on stumpage prices. Changes in stumpage value due to changes in hauling costs can be an effective tool in evaluating potential impacts on forest management activities. This study applies methods consistent to Grace’s (1997) work in which she demonstrated the effects on Alcorn County revenues as a result of lower road weight limits.

The residual value is one method of pricing standing timber. The residual, or stumpage price, is what’s left over after manufacturing costs, harvesting costs, and profit are subtracted from the finished product price (Hotvedt and Straka, 1987). The following is an example of the residual value model used for this study:

$$RV = P - MC - HC - \text{profit}$$

- RV = residual value
- P = finished product price
- MC = manufacturing costs
- HC = harvesting costs + transportation costs

This study takes the transportation portion of the harvesting cost variable and determines the effects on stumpage price if transportation costs are increased, assuming the other variables remain constant.

Preliminary Results

As shown in Tables 2, 3, and 4, there would be a significant reduction in the value of timber if the counties had mandated a lower road weight restriction. Alcorn county landowners would see a decrease of \$96.75 per ton for their timber. Oktibbeha and Wayne county landowners would lose \$19.63 per ton.

Table 2. Impacts of 40,000 Pound Road Weight Restriction in Alcorn County, MS.

Product	Stumpage Prices per ton - 2002	Value per ton w/restriction
Pine sawtimber	\$43.78	-\$52.97
Oak sawtimber	\$33.53	-\$63.22
Mix hdwd sawtimber	\$19.56	-\$77.19

Pine chip-n-saw	\$27.81	-\$68.94
Pine pulpwood	\$5.79	-\$90.96
Hardwood pulpwood	\$4.97	-\$91.78

Table 3. Impacts of 57,650 Pound Road Weight Restriction in Oktibbeha County, MS.

Product	Stumpage Prices per ton - 2002	Value per ton w/restriction
Pine sawtimber	\$43.78	\$24.15
Oak sawtimber	\$33.53	\$13.90
Mix hdwd sawtimber	\$19.56	-\$0.07
Pine chip-n-saw	\$27.81	\$8.18
Pine pulpwood	\$5.79	-\$13.84
Hardwood pulpwood	\$4.97	-\$14.66

Table 4. Impacts of 57,650 Pound Road Weight Restriction in Wayne County, MS.

Product	Stumpage Prices per ton - 2002	Value per ton w/restriction
Pine sawtimber	\$45.47	\$25.84
Oak sawtimber	\$35.51	\$15.88
Mix hdwd sawtimber	\$23.02	\$3.39
Pine chip-n-saw	\$28.85	\$9.22
Pine pulpwood	\$7.16	-\$12.47
Hardwood pulpwood	\$4.51	-\$15.12

As shown in Table 2, the value of timber is negative for all product classes in Alcorn County if a 40,000-pound road weight limit is imposed. With these prices it would be infeasible for landowners to harvest timber because they would have to pay the logger to cover current harvest costs. In Oktibbeha County, pine and hardwood pulpwood along with mixed hardwood sawtimber would have a negative value if the 57,650-pound road weight limit were imposed. Pine sawtimber, oak sawtimber, and pine chip-n-saw maintain positive values, however, landowners would still receive a lower price for their timber. Wayne County, whose stumpage prices were slightly higher than the other counties, showed only negative prices on pulpwood. The other product classes still earned a positive return, although they were significantly lower with the proposed weight restrictions.

Weight limits and transportation costs have an effect on stumpage prices. Greater weight restrictions affect forest management activity by increasing costs for producers to haul wood, lowering prices for landowners, and creates fewer silvicultural options. With pulpwood prices receiving negative values, landowners would have to pay to have it cut. This could result in unhealthy stands and could also present a fire hazard for the entire county area. Lower stumpage prices would result in lower returns for landowners, thus making timberland a less attractive investment.

CONCLUDING REMARKS

Transportation plays a vital role in forest management and production forestry. Without an efficient transportation network, the cost to procure raw material for mills would be higher and the margin of profit lower. Also, if no mills are located in a close proximity, then transportation costs are increased. If the proposed weight limits had been enforced, landowners would receive less money for their timber and in some cases they would have to pay to have it cut.

Future work in this area could be evaluating lighter hauling vehicles, to allow more wood to be hauled without exceeding the weight limit. It would be beneficial to examine how funds are allocated to county governments for road construction and maintenance. Determining the mileage statistics for county roads is also a topic for further investigation.

Acknowledgments: Our thanks are given to Dr. Gaddis and Dr. Daniels for their constructive criticisms.

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Evaluating Forest Management Intensity Among Major Landowner Groups In Mississippi: A Preliminary Analysis¹

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Abstract: Timberlands in Mississippi are owned by a diverse group of landowners: industrial owners, timberland investment management organizations (TIMOs), non-industrial private forest (NIPF) landowners, and public landowners. The objectives of each type vary, resulting in different management of their properties. This variation influences the intensity of their management and harvest decisions, which in turn affects timber inventory. This paper evaluates and compares forest management intensity of the different landowner groups in Mississippi by looking at forest management activities and expenditures. The results indicate that different landowner groups differ in the management of their timberlands. Industrial landowners and TIMOs have similar management characteristics and manage their lands more intensively than the State and NIPF landowners. Intensive forest management is significantly influenced by size of ownership, proportion of pine plantation, and type of ownership.

Key Words: NIPF landowners, TIMOs, industrial landowners

INTRODUCTION

As international and national demand for timber expands, southern U. S. forests are becoming an increasingly important source of timber. The decline in available timber inventory in the western U.S., due to federal and state regulations that have restricted harvests, has shifted a large portion of the United States demand for softwoods to the South. Thus, forest landowners in this region hold the key to the nation's supply of timber and intensive management of these forestlands will help meet this growing demand.

Intensive management has become an important aspect of forest management, especially on private timberlands. Improving timber markets and increasing timber prices make intensive management a profitable investment for landowners (Cubbage et al. 2002). Intensive forest management relies heavily on plantation establishment and is capital-intensive. It requires considerable capital investment in site preparation and planting (Guldin and Wigley 1998). Landowners engage in intensive forest management because of its productivity and economic advantages. With intensive management, return on investment is usually higher than with conventional forest management (Shiver 1998).

Timberlands in Mississippi are owned by a diverse group of landowners who have different objectives. Forest ownership objectives dictate the nature and intensity of forest management activities. Forest ownership in the United States is broadly categorized as publicly-owned and privately-owned. Public forestlands are under federal, state, county, municipal, and other local

¹ A paper presented at SOFEW session of the 2002 Southern Economic Association Conference, New Orleans, LA. Approved for publication as Journal Article No. 231 of the Forest and Wildlife Research Center, Mississippi State University.

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governmental ownership. Private forestlands are under the ownership of industrial and non-industrial landowners.

The study focuses primarily on private landowners because they control almost 70% of the total timberlands in the South (Powell et al. 1994). Therefore, they play a vital role in the long-term sustainability of the nation's timberlands. The amount and quality of timber outputs depend largely on how private timberlands are managed by these landowners (Alig and Wear 1992). Private landowners comprise a heterogeneous group that includes (1) industrial owners, (2) timberland investment management organizations (TIMOs), and (3) non-industrial private forest (NIPF) landowners. The objectives of each type vary, resulting in different management of their properties. This variation influences the intensity of their management and harvest decisions, which in turn affect timber inventory.

Despite the general recognition of differences in objectives among private landowners, little has been done to quantify and evaluate differences in management or investment (Newman and Wear 1993). A recent study enumerated the management activities and expenditures for TIMOs and industrial landowners (Rogers 2001). Similar information on NIPF landowners was collected for this study. Thus, necessary data are available to quantify the differences in management between these landowners.

This paper presents a preliminary analysis of the forest management intensity of different landowners groups in Mississippi. It compares forest management intensity of different landowner groups in Mississippi by examining their forest management activities and expenditures. Expenditure information indicates landowners' willingness to invest in timber production. A measure of landowners' capital investment in various silvicultural activities can be used in assessing forest management intensity level. Specifically, intensive forest management is associated with silvicultural practices such as site preparation, fertilization, planting and intermediate treatments. Greater application rates of these activities indicate more intensive management. All else equal, increasing levels of expenditures suggest increasing management intensity. This paper also examines the factors affecting intensive management in Mississippi timberlands.

Methodology

Data

NIPF data was obtained from annual mail surveys conducted by the Social Science Research Center, Mississippi State University that addressed the annual forest management activities and expenditures of NIPF landowners in Mississippi. Rogers (2001) obtained similar information for industrial landowners and TIMOs in Mississippi.

These data sets contain information about the expenditures of private landowners on the different forest management activities as well as the number of acres treated for each activity in 1998 and 1999. Specifically, the data from these surveys include information on capital expenditures for mechanical site preparation, chemical site preparation, site preparation burning, fertilization, regeneration (planting), natural regeneration, road construction, and other capital expenditures; expensed cost items such as timber management costs, routine or on-going expenses, and fees for professional services; timber sale expenses; and hunting/wildlife management revenues and expenses. The data sets also contain information on ownership size, forest composition and timber harvest information.

Similar information was also obtained from public forest ownerships by Bonds (2002) and was used in this study. Specifically, expenditures data on Mississippi's 16th section lands

that are classified as forestland were collected. These are lands set aside by the State to generate revenues for Mississippi's public schools. The Mississippi Forestry Commission (MFC) has been mandated to manage these school trust (16th section) forestlands.

Methods

Expenditures per acre owned on major categories of silvicultural activities were computed and compared among different landowner groups. T-tests were computed to test for significant differences between landowner groups using SAS[®] software.

A model was developed to examine factors that may account for differences in management behavior of the different landowner groups. Specifically, total silvicultural expenditures were modeled as a function of ownership type, ownership size, and forest composition (e.g., proportion of plantation pine).

Due to some differences in the nature of data collected from private and public landowners, two separate models were developed. The first model examined the factors related to intensive forest management among the private landowner groups only and the second model included both the private and public landowners. The first model was specified as:

$$\text{LNSILVI} = B_0 + B_1\text{PPINE} + B_2 \text{LNACRE} + B_3(\text{TIMO}*\text{LNACRE}) + B_4(\text{INDU}*\text{LNACRE}) + \varepsilon$$

Where: LNSILVI = natural log of silvicultural expenditures per acre owned (\$/ac)

PPINE = proportion of pine plantation

LNACRE = natural log of total acres owned

TIMO = dummy variable for ownership type
= 1 if TIMOs, 0 otherwise

INDU = dummy variable for ownership type
= 1 if industrial, 0 otherwise

ε = error term

The model for both the private and public landowners was specified as:

$$\text{LNSILVI} = B_0 + B_1\text{LNACRE} + B_2(\text{TIMO}*\text{LNACRE}) + B_3(\text{INDU}*\text{LNACRE}) + B_4(\text{NIPF}*\text{LNACRE}) + \varepsilon$$

Where: LNSILVI = natural log of silvicultural expenditures per acre owned (\$/ac)

LNACRE = natural log of total acres owned

TIMO = dummy variable for ownership type

	= 1 if TIMOs, 0 otherwise
INDU	= dummy variable for ownership type
	= 1 if industrial, 0 otherwise
NIPF	= dummy variable for ownership type
	= 1 if NIPF, 0 otherwise
ε	= error term

The dependent variable was expressed in natural logarithm form to improve functional relationships and to correct for heteroskedasticity.

Proportion of pine plantation (PPINE) was included in first model to account for the impacts of forest type on how landowners manage their lands. The subdivision of timberland among different forest types is important from a timber production standpoint (Alig and Wear 1992) because differences exist in terms of productivity between types. This variable was not included in the private and public landowner model because information on the forest composition of the State's 16th section lands was not available.

To account for the impact of timberland ownership size on management intensity, the natural logarithm of ownership size (LNACRE) was included in both models. Previous studies have shown that ownership size is a key determinant of forest management investment among landowners (e.g., Webster and Stoltenberg 1959; Straka 1985; Hyberg and Holthausen 1989).

The interaction terms in both models (i.e. acres owned nested in ownership type) represent the influence of size of ownership on silvicultural expenses within each landowner type, and thus, examines how each landowner type differs in terms of their responses to ownership size. The dummy variable for NIPF landowner category was excluded from the first model and the State dummy from the second model. Therefore, the estimated coefficient for the variable LNACRE represents the rate at which expenditures per acre owned change with the amount of acres owned for NIPF landowners. Similarly, the coefficient for LNACRE represents the rate for the State in the second model.

Initial inspection of the data showed that many landowners had no silvicultural expenses. In addition to examining the silvicultural spending of all the landowners in the sample, we also examined silvicultural spending of landowners who incurred expenses only. Therefore, the models were estimated in two ways: (1) using the full sample - including all landowners with zero and non-zero silvicultural expenses and (2) using the reduced sample - excluding landowners with zero silvicultural expenses. In all analyses, the 1998 and 1999 data sets were pooled because initial investigation showed that expenditures were not significantly different between the two years. The models were estimated using ordinary least squares regression (OLS).

Results

Private and Public Spending on Silvicultural Activities

Silvicultural activities refer to those activities that directly contribute to the production of timber, either through enhancing timber growth or returns on timber sales. As such, these expenditures result in a direct return on investment. These include expenditures on site preparation, planting, and intermediate treatments. These are the activities that make up intensive forest management. There was a significant variation among the different landowner groups with respect to the amount of money invested in the different silvicultural activities (tables 1a and 1b). In general, industrial landowners and TIMOs spent more per acre owned on silvicultural activities than did State and NIPF landowners. Among the private landowner groups, TIMOs and industrial landowners had significantly higher spending on silvicultural activities compared to NIPF landowners, averaging \$11.03/ac-owned and \$13.32/ac-owned, respectively. NIPF landowners averaged \$3.83/ac-owned for silvicultural activities. The State spent an average of \$1.56/ac-owned on silvicultural activities. Intermediate treatments accounted for almost half of this total, averaging 0.78/ac-owned.

These results provide evidence regarding the hypothesis that landowner groups manage their lands differently as different management objectives are pursued. Because the primary objective of industrial landowners and TIMOs for owning timberland is to maximize profit through returns from timber production, they manage their lands more intensively as shown by their significantly higher investment per acre owned in intensive forestry activities. Intensive forest management results in higher timber productivity, which translates to higher profits. In the South, TIMOs and industrial holdings are the most intensively managed timberlands and intensity of management has increased dramatically for these groups (Siry 2002).

Management intensity is less pronounced in the State and NIPF land holdings. This behavior is not surprising in the case of NIPF landowners. Previous studies have shown that timberlands under the ownership of NIPF landowners are often managed less intensively (see Adams et al. 1992, Kurtz et al. 1993). While timber production can be one objective of

Table 1a. Silvicultural expenses per acre owned of the private and public landowners in Mississippi (Full sample), 1998-1999.

Activities	Landowner Groups			
	Industrial (n=31)	TIMO (n=10)	NIPF (n=1,035)	State (n=174)
	\$ /ac-owned			
Site Preparation	5.05 ^a	6.53 ^a	2.02 ^b	0.78 ^c
Mechanical treatments	1.35 ^a	2.70 ^b	0.74 ^c	0.17 ^d
Chemical treatments	2.22 ^a	1.57 ^a	1.15 ^b	0.50 ^c
Burning	0.29 ^a	0.19 ^a	0.08 ^b	0.10 ^b
Fertilization	1.19 ^a	2.08 ^a	0.06 ^b	-
Planting	2.07 ^a	2.04 ^a	1.52 ^b	0.39 ^c
Intermediate Treatments	3.91 ^a	4.75 ^a	0.31 ^b	0.39 ^b
Total	11.03 ^a	13.32 ^a	3.83 ^b	1.56 ^b

Note: Means in a given row that have the same letter are not significantly different from each other at $\alpha=0.10$.

Table 1b. Silvicultural expenses per acre owned of the private and public landowners in Mississippi (Excluding landowners with zero silvicultural expenses), 1998-1999.

Activities	Landowner Groups			
	Industrial	TIMO	NIPF	State
	\$ /ac-owned			
Site Preparation	5.15 ^a (n=20)	6.53 ^a (n=10)	7.23 ^a (n=92)	1.45 ^c (n=82)
Mechanical treatments	1.46 ^a (n=14)	2.70 ^a (n=10)	9.93 ^b (n=34)	1.54 ^a (n=13)
Chemical treatments	2.31 ^a (n=17)	2.08 ^a (n=7)	5.28 ^b (n=48)	2.15 ^a (n=32)
Burning	0.32 ^a (n=13)	0.26 ^a (n=7)	0.69 ^a (n=33)	0.25 ^a (n=67)
Fertilization	1.58 ^a (n=7)	2.85 ^a (n=6)	2.78 ^a (n=15)	-
Planting	2.08 ^a (n=21)	2.07 ^a (n=9)	5.19 ^b (n=105)	0.91 ^c (n=56)
Intermediate Treatments	4.16 ^a (n=13)	4.75 ^a (n=10)	3.51 ^a (n=36)	0.86 ^b (n=64)
Total	11.04 ^a (n=23)	13.72 ^a (n=10)	10.58 ^b (n=158)	2.13 ^c (n=109)

Note: Means in a given row that have the same letter are not significantly different from each other at $\alpha=0.10$.

ownership, this may not often be the case. The objectives of NIPF landowners are more much complex considering that this landowner group is made up of a very heterogeneous group of individuals. In most cases, low management intensity is still the rule for many of these landowners. While intensive management may be accepted by the relatively few landowners whose primary goal is maximization of timber revenues (Porterfield and Moak 1977), this is not true for most of the landowners. As mentioned earlier, these landowners are much less uniform and more complex in their approaches to forest management as they pursue multiple objectives. They can be very intensive in their management like the TIMOs and industrial landowners or they can completely disregard forest management. "Doing nothing" may be thought to be both practical and cost effective by many of these landowners (Wicker 2002). Some of these landowners may perceive intensive forest management to be in conflict with recreation opportunities, scenic viewing, wildlife habitat and with other non-timber objectives. Landowners who value non-timber amenities are less likely to manage their timberlands intensively if it reduces these uses (Siry 2002).

The State's 16th section forest lands are mandated to be managed exclusively to generate revenue for Mississippi's public schools. This study suggests that the State's 16th section forest lands are managed less intensively compared to TIMOs and industrial lands. The Mississippi Forestry Commission has little incentive to manage these lands intensively because earnings from timber harvest go directly to the district school boards as public school funds. Only 15% of the timber receipts are placed in an escrow fund to cover the actual cost of forest management (MS Code, Sec. 29-3-47). The Commission may therefore be constrained by this escrow fund allocated by the school boards. While the Commission makes management recommendations for these lands, the district school boards make the final decision as to what activities can be performed.

Factors Affecting Forest Management Intensity

Landowner groups differed in their investment in silvicultural practices, with the TIMOs and industrial landowners managing more intensively compared to the non-industrial and State landowners. Factors accounting for these differences were evaluated using ordinary least squares regressions.

In model 1, the proportion of plantation pine (PPINE) was highly significant and positively related to silvicultural expenses, indicating that the proportion of plantation pine is an important factor influencing silvicultural expenses (table 2). Higher proportion of plantation pines leads to higher silvicultural spending per acre owned. This suggests that there are greater opportunities for intensive management as the proportion of pine plantation increases. Siry (2002) also reported that intensive forest management is commonly associated with pine plantations. Total acres owned (LNACRE) and the associated ownership interaction terms were also significant and positively related to silvicultural expenses. These variables represent the influence of ownership size on silvicultural expenses within each landowner group. Looking at the full sample (i.e. including those with zero expenditures), there is a tendency to invest more in intensive forestry activities as size of holdings increases for all landowner groups. Large operations invest more in silvicultural activities per acre owned. Previous studies have shown that ownership size is a significant factor that influences landowners' forest management decisions (Greene and Blatner 1986, Hyberg and Holthausen 1989, Birch 1997). Holmes (1986) found a positive relationship between ownership size and the rate of application of intermediate

treatment activities. Landowners with smaller holdings are less likely to invest in these activities because fewer management options are available in smaller tracts.

Table 2. Regression analysis results for the full sample (standard errors in parenthesis)

Dependent Variable - natural log of silvicultural expenses per acre owned		
Variables	OLS Estimates	
	Model 1 (n=1,076)	Model 2 (n=1,250)
Constant	-0.51** (0.12)	-0.49** (0.12)
PPINE	0.70** (0.09)	-
LNACRE	0.15** (0.03)	0.13** (0.02)
TIMO*LNACRE	0.09** (0.03)	0.14** (0.03)
INDU*LNACRE	0.04** (0.02)	0.09** (0.02)
NIPF*LNACRE	-	0.05** (0.01)
R²	0.17	0.12
F-stat	56.07	41.97

**significant at $\alpha=0.01$

Model 1 - Private landowners only

Model 2 - Private landowners and State

The model including State ownerships (model 2) was statistically significant as were all the variables in the model. All the variables were positively related to silvicultural expenses. These variables explain the influence of size of holdings on silvicultural expenses within each landowner type. As with the previous regression, these results indicate that landowners with larger holdings tend to invest more per acre owned on silvicultural activities. This is true for all the landowner groups. The sign of the coefficients indicates that the TIMOs and industrial landowners tend to spend increasingly more as size of holdings increases compared to NIPF landowners and the State.

Table 3 presents regression results for landowners who spent money on silvicultural activities. Landowners who incurred no silvicultural expenditures were therefore excluded from the sample. The proportion of pine plantation and size of ownership are important factors influencing silvicultural expenses for landowners incurring silvicultural expenses. Proportion of pine plantation was significant and positively related to silvicultural expenses. Ownership size was a significant determinant of silvicultural spending for all landowner groups but is inversely related to spending per acre owned in contrast to the model estimated using all landowners. As ownership size becomes larger, spending per acre decreases. This could be attributed to economies of scale. The relationship between ownership size and silvicultural spending is more pronounced among NIPF landowners compared to TIMOs and industrial landowners. This

difference is statistically significant when comparing NIPF landowners and TIMOs ($F=13.46$, $p=0.0003$) as well as NIPF landowners and industrial landowners ($F=12.41$, $p=0.0005$). However, the interaction terms for TIMOs and industrial landowners are not significantly different ($F=0.34$, $p=0.56$), which suggests that these two landowners might be behaving the same way. The effect of ownership size is less pronounced for both of these groups. One possible reason for this is that the scale of operation of these landowners might be sufficiently large that additional economies of scale are minimal. Therefore, the reduction in their average expenses as ownership size increases becomes less apparent.

Table 3. Regression analysis results for the reduced sample (standard errors in parenthesis)

Dependent Variable - natural log of silvicultural expenses per acre owned		
Variables	OLS Estimates	
	Model 3 (n=191)	Model 4 (n=300)
Constant	3.25** (0.33)	3.49** (0.29)
PPINE	0.92** (0.24)	—
LNACRE	-0.23** (0.06)	-0.31** (0.04)
TIMO*LNACRE	0.11** (0.04)	0.22** (0.03)
INDU*LNACRE	0.08** (0.03)	0.22** (0.03)
NIPF*LNACRE	—	0.19** (0.02)
R²	0.11	0.39
F-stat	7.78	46.85

**significant at $\alpha=0.01$

Model 3 - Private landowners only

Model 4 - Private landowners and State

All the variables in model 4 (private and State) were significant and ownership size was inversely related to silvicultural expenses. These results also indicate that landowners with larger holdings tend to have lower per acre expenditures for silvicultural activities. This trend is true for all the landowner groups. The effect of ownership size is more pronounced for the State compared to the private landowner groups. For instance, a 1% increase in ownership size reduces spending by 0.31% for the State, 0.20% for the NIPF group, 0.12% for the industrial group, and 0.09% for the TIMOs. An F-test comparing the difference between the coefficients of the interaction terms for TIMOs and industrial landowners indicates that they are not statistically different ($F=0.79$, $p=0.37$).

IV. Discussion

The long-term sustainability of the nation's timberlands depends largely on the forest management activities of the different timberland landowner groups. Intensive management by these landowners is important in ensuring the adequate flow of wood in the nation's timber economy. However, these landowners are very heterogeneous and they exhibit different forest management behavior. This study provides evidence that landowner groups differ in the management of their timberlands. Industrial landowners and TIMOs have similar management characteristics. In general, these two landowner groups manage more intensively than the State and NIPF landowners. Industrial landowners use their timberlands to produce timber in order to support their wood-processing facilities. They consider their timberland as an important factor of production that is needed to achieve their primary goal of maximizing profit. While TIMOs do not produce timber to support wood processing facilities, they consider timber investment as one major component of their diversified portfolio and their main objective is also to maximize profit. NIPF landowners manage less intensively and differ significantly from TIMOs and industrial landowners. These landowners are very heterogeneous and therefore manage their lands less uniformly. Their actions are much more complex as they pursue multiple objectives. The Mississippi Forestry Commission also manages Mississippi's 16th section forest lands less intensively because its management decisions may be constrained by the escrow funds allocated by the school district boards.

The preliminary analyses presented in this study suggest that, in general, intensive forest management is influenced by size of ownership, proportion of plantation pine, and types of ownership. These factors only account for some of the differences in management intensity among the different landowner groups. While this study provided an important insight into the forest management behavior of the different landowner groups in Mississippi, future research should focus on classifying these landowners more definitively to provide more accurate information on the differences in their behavior. For instance, how nontimber benefits of forest management come into play when landowners make decisions to intensively manage their lands is an important question that warrants investigation. There is also a need to further investigate the functional relationships of the models presented in this study. The results of the regression models show that only a small proportion of the variation in management intensity is explained by the independent variables included in the model. Moreover, there might be a need to explore other models (e.g., Tobit regression) that are more appropriate when majority of the dependent variable have zero values, as the case in this study. These suggestions will be explored further as the study progresses.

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Economic Impact of Commercial Hunting Outfitters and Clientele in Mississippi¹

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Abstract: Hunting activities provide an economic enhancement to rural economies. Traditional economic impact analyses enumerate hunter expenditures and derive their economic impacts. However, hunting outfitters, an integral component of the hunting industry, have largely been ignored in these studies. In addition to their own expenditures, outfitters impact local economies by drawing large numbers of out-of-region hunters. These out-of-region hunters have a much greater impact on local economies than do local hunters. Their expenditures represent an import of dollars to a region and they generally spend more than locals. This study incorporates the economic contributions of both outfitters and their clientele. A survey of Mississippi outfitters and their clientele was conducted during the 1999-2000 hunting season to determine their expenditures in pursuit of white-tailed deer (*Odocoileus virginianus*), waterfowl (*Anas* spp.), quail (*Colinus virginianus*), and dove (*Zenaida macroura*). Results indicated that Mississippi outfitters generated \$13.8 million in total output, \$7.5 million in value-added, and 186 full- or part-time jobs. Clientele impacts include \$16.9 million in total output, \$10.2 million in value-added, and 247 full- or part-time jobs.

Key Words: hunting, hunting outfitters, economic impacts, rural economic development

INTRODUCTION

Commercial hunting outfitters operating in Mississippi offer a wide variety of hunting opportunities and other related services. The level of service offered to clientele varies from providing access to a hunting site, to offering a full range of amenities that includes lodging, meals, clothing, supplies, and guided hunts. The variety of hunting opportunities and level of services offered attract local and out-of-state hunters. This study focused on Mississippi's commercial outfitters and their clientele. These businesses primarily provide hunting opportunities for white-tailed deer (*Odocoileus virginianus*), waterfowl (*Anas* spp.), Northern bobwhite quail (*Colinus virginianus*), and morning dove (*Zenaida macroura*).

Similar to other tourism related activities, the ability of commercial outfitters to attract out-of-state sportsmen provides a considerable monetary contribution to rural economies (Johnson and Moore 1993). The expenditures of out-of-state sportsmen tend to be greater than that of local hunters (USDI and USDC 2002). Steinback (1999) found that impacts resulting from expenditures of non-resident anglers were five times greater than that of local anglers. As a result, outfitter clientele expenditures can greatly enhance the economic impacts to local

¹A paper presented at the SOFEW session of the 2002 Southern Economic Association Conference, New Orleans, Louisiana on November 24-26, 2002. Approved for publication as Journal Article No. FO-217 of the Forest and Wildlife Research Center (FWRC), Mississippi State University. We thank D. L. Grebner and K. M. Hunt for constructive manuscript reviews. We thank the Mississippi Outfitters Association for assisting with funding for this research and individual Mississippi outfitters who, as members of the Mississippi Outfitters Association or the Mississippi Outfitters and Guides Association, were willing to provide us with information about their businesses and/or permitted us to survey their clientele. We also thank the FWRC for internal support.

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economies. Most of Mississippi's commercial outfitters operate in rural areas with small local economies. Their expenditures combined with those of out-of-region hunters represent a monetary influx to the local economy.

A number of studies have determined the economic contribution of hunters (Grado et al., 1997, Burger et al., 1999, Grado et al., 2001); however, the economic impact resulting from activities of hunting outfitters and their clientele have not been determined. Davis et al. (2002) studied the impact of commercial hunting outfitters on the Mississippi economy, but did not account for the impacts resulting from outfitter clientele. The economic contribution that results from the operation of commercial outfitters and local expenditures of their clientele may be substantial. The importance of commercial hunting outfitters can be appreciated by quantifying the economic contribution that results from their activity and that of the clientele they attract to Mississippi. This will assist public agencies and policy makers as they contemplate various regulations and laws that affect Mississippi's wildlife resources. Commercial markets based on wildlife are large, growing, and diversifying (Freese and Trauger 2000). Economic growth can be encouraged by the actions of federal and state governments and wildlife management agencies. These organizations enhance the resource base of this growing market, which utilizes Mississippi's wildlife and forest resources yet also spurs rural development.

Methods

Hunting outfitters and their clientele were surveyed throughout Mississippi during the 1999-2000 hunting season. At the time of the study, there were 47 hunting outfitters in Mississippi that were members of the state's two professional hunting outfitter associations, the Mississippi Outfitters Association and the Mississippi Outfitters and Guides Association. Contact information for the 47 hunting outfitters was obtained from these two associations. Outfitters were contacted, the purpose of the survey described, and then they were invited to participate in the study. The outfitter survey included questions relating to operational and overhead expenses, level of service provided and associated charges to their clientele, the number of their full- and part-time employees, and salaries and wages paid. Thirteen outfitters permitted on-site and mail surveys of their clientele. Questions from these surveys related to daily outfitter and non-outfitter related expenditures incurred while hunting with an outfitter in Mississippi. All survey information was used to determine expenditures per activity day for outfitters and clientele. These expenditures were grouped by species pursued: deer, waterfowl, quail, and dove. The expenditure information, along with the number of clientele activity days, was used to determine economic impacts of hunting outfitters and their clientele by species on the Mississippi economy.

Economic impacts of commercial hunting outfitters and their clientele were determined with the Impact Analysis for Planning (IMPLAN) input-output software package (Olson and Lindall 2000). IMPLAN was used to model the Mississippi economy and identify impacts of outfitter and clientele expenditures. Weighted average expenditures were allocated to the appropriate IMPLAN sector and a determination was made on the resulting economic impacts. The impacts included total sales, value-added, and employment. This analysis was repeated for each game species. State-level economic impacts were determined by extending the weighted average expenditures and activity days by species to represent the total number of outfitters operating in Mississippi.

Results

In the preliminary phone contact, 29 outfitters reported species hunted and the number of clientele activity days during the 1999-2000 hunting season. Ten of these outfitters agreed to participate in a more detailed survey concerning their business expenditures. Thirteen granted permission to survey their clientele.

Nine outfitters reported clientele attendance for deer, eleven for waterfowl, ten for quail, and four for dove. Five of these outfitters reported attendance for more than one species. To estimate total attendance by species for the 47 Mississippi outfitters, attendance by species for the 18 outfitters that did not provide attendance information was extrapolated from attendance rates for the 29 outfitters that did provide attendance data (Table 1.)

Table 1. Activity days of hunting for Mississippi outfitter clientele during the 1999-2000 hunting season.

	Known	Estimated	Total
Deer	3,236	1,713	4,949
Waterfowl	2,856	1,512	4,368
Quail	6,500	3,441	9,941
Dove	862	456	1,318
Total	13,454	7,123	20,577

Expenditure averages by activity day for outfitters and clientele were determined from survey responses (Table 2). Dove outfitters did not participate in the detailed outfitter survey, so expenditures were assumed similar to the most comparable of the other three, which was waterfowl.

Table 2. Average Mississippi outfitter expenditures per hunter activity day by species for the 1999-2000 hunting season (2002 dollars).

Species	Deer (n=4)	Waterfowl (n=4)	Quail (n=2)	Dove ^a
Expenditures (\$)	458.99	141.38	513.15	141.38

^aEstimated from waterfowl survey data.

Clientele were surveyed at 13 outfitter locations, and at two of these locations clientele sought either one of two species. As a result, expenditure averages were available for 15 outfitter clientele as defined by species sought. Outfitter clientele reported average expenditures per activity day for the same four game species (Table 3).

Table 3. Average clientele daily expenditures by species in Mississippi for the 1999-2000 hunting season (2002 dollars).

Species	Deer (35/3) ^a	Waterfowl (81/8) ^a	Quail (20/2) ^a	Dove (15/2) ^a
Expenditures (\$)	665.83	372.27	418.03	334.33

^a(Number of clientele surveyed/number of outfitters participating)

Activity days and expenditures by species for outfitters and clientele in Mississippi were combined to determine economic impacts of each group on the Mississippi economy. Economic impact of outfitters included direct, indirect, and induced effects and totaled nearly \$14 million in total sales output, \$7.5 million in value-added, and 186 full- or part-time jobs for the Mississippi economy (Table 4). The economic impact of outfitters was based on outfitter expenditures funded by clientele fees as well as other sources (e.g., debt and other hunting-related revenue).

Table 4. Economic impacts of Mississippi outfitters for the 1999-2000 hunting season (2002 dollars).

Species	Deer	Waterfowl	Quail	Dove	Total
Total Output (\$)	3,676,148	1,055,175	8,788,658	318,388	13,838,369
Value-added (\$)	1,799,199	574,215	4,977,476	173,263	7,524,153
Employment #	49	14	120	4	186

The economic impact of Mississippi outfitter clientele was even greater than outfitter impacts. Total economic impacts for clientele in the pursuit of deer, waterfowl, quail, and dove amounted to nearly \$17 million in total sales output, over \$10 million in value-added, and 247 full- or part-time jobs (Table 5).

Table 5. Economic impacts of Mississippi outfitter clientele for the 1999-2000 hunting season (2002 dollars).

Species	Deer	Waterfowl	Quail	Dove	Total
Total Output (\$)	5,686,831	2,926,365	7,554,931	789,866	16,957,993
Value-added (\$)	3,657,893	1,636,528	4,518,462	440,723	10,253,606
Employment #	87	41	109	11	247

Discussion

Hunting outfitters operating in Mississippi create a sizable economic impact on the state's economy. This economic impact is the result of, not only the expenditures of the hunting outfitters, but also the expenditures of their clientele who purchase additional goods and services in the state during their trip. This additional spending is of great benefit to local economies and a direct result of the outfitter's ability to attract hunters from outside the region who engage the services of Mississippi's outfitters.

It is important to note that outfitter impacts are, to a large degree, included in clientele impacts. The primary source of funds available to outfitters for their operating expenditures are clientele payments. Any impacts resulting from these payments are accounted for in the computed clientele impacts. Only outfitter expenditures generated by funds other than clientele payments (e.g., savings, loans, and other revenues) generate additional economic impacts. Therefore, clientele economic impacts should be greater than outfitter impacts, unless outfitters receive substantial revenues from other sources, since clientele expenditures include purchases of additional goods and services in the state economy in addition to payments to the outfitters. The economic impacts of outfitters and their clientele can be summed if clientele payments to outfitters are excluded in the calculation of clientele impacts.

In our study, clientele impacts were greater than outfitters for all game species except quail. The expenditures per activity day for quail clientele are \$95 less than for quail outfitters, and the corresponding economic impacts for quail clientele are less than that of the quail outfitters. This resulted from corporate sponsorships that accounted for up to 80% of outfitter revenues (R. Halford, Longleaf Plantation, pers. commun., 2002). Quail clientele in this study reported expenditures that did not reflect outfitter fees that were paid through corporate sponsorships; however, these payments may be included in the total economic impact.

CONCLUSION

During the 1999-2000 hunting season, Mississippi hunting outfitters and their clientele produced a substantial impact on the state's economy. The activities of outfitters and their clientele resulted in \$17 million in industry output, over \$10 million in value-added, and 247 full- or part-time jobs and nearly \$14 million in industry output, \$7.5 million in value-added, and 186 full- or part-time jobs, respectively. The activities of Mississippi's hunting outfitters resulted in a sizable impact on the state's economy, and the vast majority of this economic activity occurs in the state's rural areas where hunter expenditures can substantially enhance local economies and rural development. This study demonstrated the contribution of hunting outfitters to the Mississippi economy. Federal and state government and wildlife management agencies can increase the economic impact of the hunting outfitter industry by supporting legislation and policies that enhance the use of Mississippi's renewable wildlife and forest resources.

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From Senators to the President: Solve the Lumber Problem or Else

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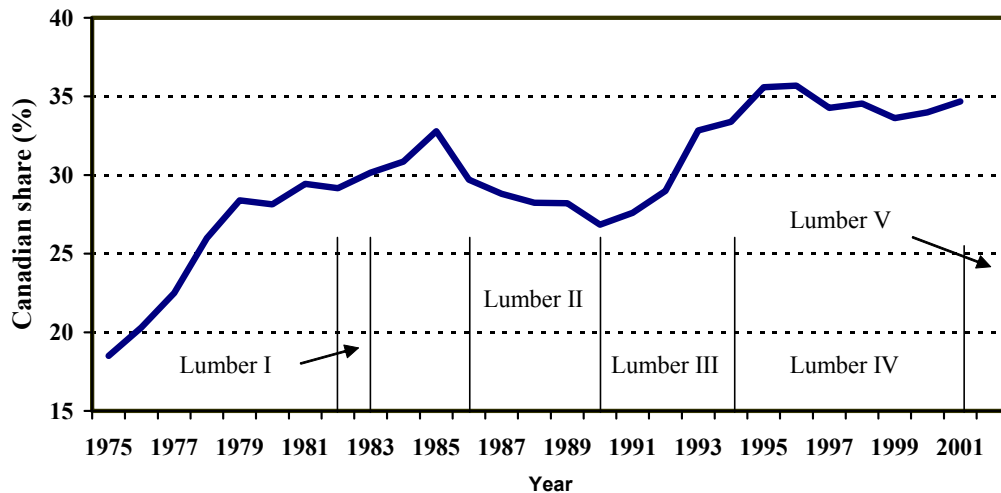
Abstract: This paper uses key events associated in the two decade-long U.S.-Canada softwood lumber trade dispute to present the dynamic relationship between U.S. Congress and Administration in international trade policy. We have found that the Administration responded quickly to several letters from a group of U.S. Senators demanding a solution to the lumber problem. We used a roll call analysis to analyze the factors influencing the senators' willingness to pressure the President on behalf of the U.S. lumber industry. The results show that the economic importance of the lumber industry in a state, the characteristics of the Senator, and logrolling are correlated with the Senators' signature on these letters.

Key Words: U.S.-Canada softwood lumber dispute, lumber industry, special interest theory, public choice, logrolling.

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INTRODUCTION

The United States and Canada have been fighting a softwood lumber “trade war” for more than two decades. Although the U.S. lumber industry had periodically expressed concerns about imports of Canadian lumber since at least 1962 (Gorte 2002), the trade dispute officially started in 1982 when the Canadian share of U.S. softwood lumber consumption increased from 20 percent in the middle 1970s to 27 percent (Figure 1). The dispute went through four rounds between 1982 and 2001 (Zhang 2001), and the fifth round started around March 31, 2001 when the 1996 US-Canada Softwood Lumber Agreement (SLA) expired. Since May 2002, the U.S. has imposed a 27.2 percent tariff on Canadian softwood lumber imports, and Canada is now appealing both to the World Trade Organization (WTO) and trade dispute settlement body under the North America Free Trade Agreement (NAFTA).



DATA SOURCES: AF&PA (VARIOUS YEARS)

Figure 1. Canadian market share of U.S. softwood lumber consumption between 1975 and 2001 and the five periods of U.S.-Canada softwood trade dispute

The softwood lumber trade dispute has been the largest and longest trade dispute between the two otherwise friendly neighbors (Zhang 1997; Cashore 1998). In the most recent four rounds (started in 1985, 1991, 1994, and 2001), a number of U.S. Senators involved themselves indirectly in the negotiations by writing letters to the President and other administrative branches urging them to resolve the lumber “problem” through negotiation with Canada or by imposing tariffs that protect the U.S. domestic lumber industry from increasing Canadian softwood lumber imports. Several U.S. Presidents, who sought to get concessions from Congress on other trade matters (such as fast track authority) and/or political support on other unrelated issues, gave in each time to these Senators. Although these demands are expressed informally in the context of letters rather than formally in the context of floor votes, the self-selection reflected in the

expression of these demands presents a good opportunity to investigate factors that influenced the Senators' positions.

The purpose of this paper is to use softwood lumber as a case study to present evidence on the dynamic, albeit less-visible, relationship between the U.S. Congress (the legislative branch) and the President (the executive branch) with respect to formulation of international trade policy. We draw from public choice theory to shed light on both the incentives facing Senators who are deciding whether to be signatories to these letters and the incentives facing Presidents who accede to these demands. The results of this study have implications for U.S. trade policy. This paper starts with a review of public choice theory in relation to the softwood lumber case, followed by a list of key events and a series of Senate letters demanding that the President(s) act to "solve" the lumber problem. The fourth and fifth sections present the hypotheses, data, and results of a roll call analysis of factors influencing Senators' willingness to sign these letters. The final section presents conclusions and discussion.

Literature Review and Research Methods

The primary methodology for this study is the theory of public choice, which attempts to use economics to understand and to evaluate how government operates and imposes or lifts regulations such as tariffs. Two contradicting theories of regulation have been proposed and tested empirically. On the one hand, the "public interest" theory assumes that legislators and other public officials make decisions that are in the "public interest," which is social welfare-maximizing. On the other hand, proponents of the "interest group" theory (or capture theory, constituent interest theory), believe that political decisions are motivated by the availability of political rents and the attempts by politicians to capture those rents (Stigler 1971; Peltzman 1976; Becker 1983; Rausser 1982; Zusman 1976). Both theories have empirical support, although the interest group theory has fared better than the public interest theory recently (e.g., Kalt and Zupan 1984; Peltzman 1984; Berg and Tschirhart 1988; Noll 1989; Marks and McArthur 1990).

Sometimes economically efficient choices may coincide with choices in the interest of one or more groups, and there is a need to disentangle economic and political influences. Accordingly, a hybrid theory which allows for the influence of both interest groups and economic efficiency has been proposed (e.g., Joskow 1972; Noll 1989). These theories have been tested in the utility industry (e.g., Nelson 1982), oil industry (e.g., Becker 1984), transportation (e.g., Teske et al. 1994), agriculture (e.g., Gardner 1983, 1987; Bullock 1992a, b; Rausser and Forester 1990), and with respect to endangered species (Mehmood and Zhang 2001). They have been used to explain forest-related issues (e.g., Kalt 1988; O'Toole 1988), but an empirical test of them in the forestry literature can only be found in working papers (e.g., Crone 1995; MacNair et al. 1995).

We use these theories to explain the outcomes of the softwood lumber disputes and conduct a roll call analysis to isolate the political and economic factors influencing U.S. Senators' willingness to informally pressure the U.S. President. Specifically, we analyze measures of constituent interest to explain the pattern of signatures on two key letters sent by U.S. Senators in 1991 and 2001 to the Presidents serving in those years, demanding that they act to impose tariffs on the import of Canadian softwood.¹ We find that the relative political muscle

¹ As we will see in the next section, more pivotal letters could exist. However, only these two letters have the signature of more than 50 Senators. We expect Senators, in considering to sign or not to sign on these other letters, acted in the same way as in the two letters studied here.

of timber interests versus the construction industry is a significant factor in explaining Senators' willingness to sign these two letters.

Key Events in the Softwood Lumber Disputes

On October 7, 1982, the United States Coalition for Fair Canadian Lumber Imports, on behalf of a number of U.S. lumber producers, filed a petition to the U.S. International Trade Administration (ITA) alleging that certain softwood lumber imports from Canada were subsidized by the Canadian and several provincial governments through low stumpage fees. It therefore requested a countervailing duty against Canadian softwood lumber imports. After investigation, the ITA determined that such stumpage systems were not provided to any specific industry or group of industries in Canada and did not provide goods at preferential rates. It then concluded that Canadian lumber imports did not qualify for a countervailing duty (ITA 1983). The negative determination by the ITA marked the end of Lumber I.

In May 1986, a renamed Coalition for Fair Lumber Imports (hereafter referred to as the Coalition) petitioned the ITA seeking to reverse the finding in Lumber I. The ITA complied by reversing its earlier ruling and issuing a preliminary determination in October 1986 that Canadian softwood did benefit from government subsidies. The International Trade Commission found injuries to domestic U.S. lumber producers.¹ As a result, a 15 percent countervailing duty was immediately placed on Canadian softwood lumber bound for the U.S., contingent on a final determination to be made by December 30, 1986 (ITA 1986). However, the final determination was averted, and the countervailing duty was never implemented. Instead, the U.S. and Canada negotiated a Memorandum of Understanding (MOU) which transferred collection of the proposed countervailing duty by the U.S. to the collection of an export tax by Canada. Subsequent amendments to the MOU allowed provincial governments, which own most Canadian forest lands, to increase their stumpage fees in lieu of the full export tax. The policy, applied either as an export tax or stumpage fee adjustment, was designed to increase the price of Canadian lumber in U.S. markets and to reduce any Canadian competitive advantage arising from the alleged subsidy (Wear and Lee 1993). This period is referred to as Lumber II.

During this period, hearings were conducted and several bills were introduced in the U.S. Congress with the intention of taking formal trade action to reduce the impacts of the alleged Canadian timber subsidy on U.S. producers. The key events in this period are associated with the initiation of the U.S.-Canada Free Trade Agreement. Since Congress has jurisdiction over trade and commerce, the President cannot rely upon his inherent foreign relations power in order to negotiate an international trade agreement and ensure that it will be faithfully implemented by Congress. So when the negotiation process started in September of 1985, President Reagan made it clear to Congress that he wanted to have a "fast track" negotiating authority, under which Congress would enact legislation setting out what the President was authorized to negotiate. Then, at the President's request, the relevant committees of jurisdiction (the House Ways and Means Committee and the Senate Finance Committee) would vote on whether to grant authority to pursue a proposed negotiation. If approval was given, the President would proceed with negotiations and any resulting agreement would then be put to Congress for approval which requires a simple majority and no amendments could be added.

¹ Both subsidy and injury must be found for adverse action in a countervailing duty case (Figer et al. 1982; Fox 1991). The International Trade Commission also found injury in Lumber III and IV and a threat of injury in Lumber V.

Not surprisingly, when President Reagan formally notified the Senate and House committees of jurisdiction that he intended to enter into negotiations with Canada regarding a U.S.-Canada Free Trade Agreement, American interests with grievances against Canada began to lobby Congress to set conditions on the President's negotiating authority. On November 15, 1985, sixty-four members of Congress wrote to Secretary of State, George Schultz, urging him to resolve the softwood lumber issue before commencing the free trade negotiations (Apsey and Thomas 1997).

The critical holdup was in the Senate Finance Committee. Several Senators on the Committee (Bob Packwood, Chair, OR; Max Baucus, MT, Steven Symms, ID) were from lumber producing states and two of them were facing reelection in 1986. They were adamant about restricting Canadian access to the U.S. market (Apsey and Thomas 1997). After the Senate Finance Committee's straw vote on April 11, 1996, which showed that if a formal vote were held at that time the Administration would not receive fast-track authority to commence the negotiations, the Administration began to make commitments. In an infamous hand-written annotation on a letter to Senator David Pryor (D-AR) on April 17th urging him to vote in favor of fast track authority, U.S. trade Representative Clayton Yeutter added the prophetic words, "[W]e will get timber fixed...." (Apsey and Thomas 1997). On the basis of these kinds of assurances the Finance Committee relented and failed to disapprove of the request for negotiations on free trade on a 10-10 vote. Later, another committee member, Senator Lloyd Bentsen (D-TX) allowed as how it could have just as easily been 11-to-9 or even 12-to-8 (Ritchie 1997 p.68). The Congress was sending a message to the White House. Free trade was simply a pawn in this Washington power game (Ritchie 1997 p.68). As mentioned earlier, the Coalition soon filed another complaint to ITA, seeking a countervailing duty on Canadian softwood lumber import in May 1996.

On September 4, 1991, the Canadian government notified the U.S. government that it would withdraw from the MOU one month later, as it had met and would continue to honor all MOU commitments. While Canada could legally do so under MOU, this action backfired in Washington, DC. In response, 66 Senators wrote a letter in September 1991 to the President and urged him "either to press the Canadian Government to live up to its commitments or, if it refuses, to take immediate action under U.S. trade law in order to offset Canadian subsidy." They further stated, "if these remedies are not pursued, we are prepared to find a legislative remedy to fully offset Canada's timber subsidies." The Administration responded quickly with self-initiated trade proceedings even without the lumber industry's formal petition, which was rare in the history of U.S. trade dispute with other countries.

The ITA imposed an interim duty of 14.48 percent in March 1992 and a final affirmative countervailing duty of 6.51 percent in May 1992. By this time, the U.S.-Canada Free Trade Agreement (FTA) had been negotiated and brought into force. The FTA replaced the court procedures used in both Canada and U.S. in dealing with trade dispute before 1988 with a bi-national panel of five experts in law and international trade for the review of ITA determinations. Under the FTA there is no appeal from a majority decision of the panel and their decision becomes binding upon the parties. A panel of three Canadians and two Americans was convened on July 29, 1992. In its first decision delivered on May 6, 1993, the panel remanded the matter to the ITA for clarification of confusion in the ITA final determination. In response, the ITA almost doubled the duty to 11.54 percent. In its final decision issued on December 17, 1993, the panel split three to two along national lines and nullified the ITA's determinations. The U.S. appealed to an extraordinary challenge committee, which is justified under the FTA for extraordinary

circumstances. The committee (two Canadians and one American), split again along national lines, ruled on August 3, 1994, and confirmed the panel's decision. This period was referred to as Lumber III.

Soon after the committee's rulings, the Coalition filed a lawsuit in the Appellate Court of the U.S. in Washington, D.C., challenging the constitutionality of the bi-national panel dispute resolution process in the FTA (and the North American Free Trade Agreement, or NAFTA). At this moment, seeking congressional approval for NAFTA was one of the top priorities of the Clinton Administration. Not willing to see the court to determine the fate of NAFTA, the Administration requested the Coalition to drop the lawsuit and promised to start consultation with the Canadian government. The Coalition, which regarded consultation as negotiation, dropped the suit and government-to-government consultation was started in December 1994. In February 1996, an agreement-in-principle was reached, and the final Softwood Lumber Agreement (SLA) was signed in May 1996. This concluded the period of Lumber IV. During this period, a few dozen letters had been written by U.S. Senators to the President or Commerce Secretary or U.S. Trade Representative. These letters typically urge the Administration take action or pressure Canada to negotiate.

The SLA was scheduled to expire on March 31, 2001. On March 2, 2001, a group of 51 Senators wrote to the President, urging him and his Administration "to make resolving the problem of subsidized lumber imports from Canada as a top trade priority." The Coalition filed another complaint to the ITA and requested countervailing and antidumping duty on Canadian lumber imports on April 1, 2001, immediately after the expiration of the SLA. The ruling from ITA (and ITC) was swift. They imposed an interim countervailing duty of 19.3 percent on August 10, 2001 and a "permanent" (countervailing and antidumping) tariff of 27.2 percent in May 2002.

It is evident that the two letters from the Senators to the President in 1991 and 2001 brought immediate action from the Administration and the Coalition. This study uses the traditional roll call analysis model and logistic regression techniques to analyze the actual signatory of the 1991 and 2001 letters. We feel that using the traditional roll call analysis on Senatorial letters (not legislative bills) is justified on two fronts. First, these letters establish the Senators' positions and demonstrate their willingness to "go after something" that is demanded by constituent interests. The Administration's willingness to act in 1986 and to respond quickly in 1991 after Canada withdrew from the MOU and in 2001 after the SLA expired demonstrated that Congressional pressure is important. Second, no legislative vote has ever taken place for any of the proposed bills related to softwood lumber trade.¹ All of the six bills introduced in 1985 and two bills introduced in 1995 were aimed at imposing countervailing duties on Canadian imports. These bills have had bipartisan sponsorship (69 democrats and 33 republicans are

¹ These bills are *the Canadian Softwood Import Control Act*, HR 1088 (Congressional Record 7 February 1985, No. 13, H355); *the Softwood Lumber Stabilization Act of 1985*, S. 1224 (Congressional Record 24 May 1985, No. 70, S 7214), *the Wood Products Trade Act of 1985*, HR. 1648 (Congressional Record 21 March 1985, No. 33 H 1358) and S. 982 (Congressional Record 23 April 1985, No. 48, S 4635); *Natural Resource Subsidy Amendments*, HR. 2451 (Congressional Record 9 May 1985, No. 60 H 3085) and S. 1292 (Congressional Record 13 June 1985, No. 79 S 1292), and *Emergency Lumber Act of 1995*, S.1392 (Congressional Record 3 November 1995) which is the same as HR 2082 (Congressional Record 18 December 1995).

sponsors and cosponsors of the four House bills, 22 republicans and 13 democrats of the four senate bills). A bill introduced in 1997, aimed at neutralizing the SLA, also enjoyed wide support and had 59 sponsors and cosponsors (19 democrats and 40 republicans) to date.¹ Since these bills have never come on the floor for a vote, it is unclear how a traditional roll call analysis can be applied.

Hypothesis and Data

We used a linear logistic regression to analyze the determinants of U.S. Senators' signatures on the 1991 and 2001 letters to the Presidents on softwood lumber. The dependent variable, Letter, is binary, taking the value of "1" for a Senator who signed the letter. The independent variables include five variables that represent the constituent interest of a state—Lumber Production, Lumber Production Rank, Top 20 Lumber Producer, Softwood Volume Per Capita, and Building Permit.² They also include characteristics of the Senators, such as party affiliation (Party), service on the Finance Committee (Finance), years of service in the U.S. Senate (Years), and environmental score by the League of Conservation Voters (LCV Score). Finally, a variable representing whether a state is bordering with Canada is included.

Lumber Production is measured as the total softwood production in million board feet in 1991 and 2001, respectively. Lumber Production Rank is the ranking of state in terms of lumber production, with 1 being the largest producer, and 50 the smallest producer. Top 20 Producer is a binary variable, taking the value of 1 for the top 20 softwood lumber producing states. These variables represent the influence of softwood lumber industry in a state, and are expected to have a positive, negative, and positive sign, respectively. Data for these variables are from U.S. Bureau of Census (1992, 2002) and Spelter and McKeever (2001). The variable Softwood Volume Per Capita measures the standing volume in thousand board feet of softwood timber in a state. It represents the potential of softwood products (including lumber) that can be produced from the state. The data for this variable are from Powell et al. (1994) and Smith et al. (2001). As the 2001 data for this variable are not available, we used the latest, 1997 data in this paper. Since raising domestic lumber price under protective trade measures can enhance the returns to softwood timber owners, this variable can be seen as the broadness of political support for a softwood lumber trade barrier from a state. Consequently, it is expected to have a positive sign.

The variable representing the influence of consumers (Building Permit) is measured in 1000 units and is expected to have a negative sign. Data for this variable are from U.S. Bureau of Census website (<http://www.census.gov/const/www/C40/table2.html>). We have also collected data on housing starts from another U.S. Bureau of Census website. Not surprisingly, housing

¹*Americans for Affordable Housing Act*, HR 1526 (Congressional Record 1 May 1997).

² We also tried to use the wood products (SIC 24) industry' share of gross state products as a measure of lumber producers' political influence with the understanding that this measure covers the contribution (to a state economy) by hardwood lumber and engineered wood products producers. Data were collected from U.S. U.S. Department of Commerce Bureau of Economic Analysis website (<http://www.bea.doc.gov/bea/regional/gsp/>). This variable has some correlation with the three pure softwood lumber measures. The results (using this variable to replace the three pure softwood lumber measures) are similar to these reported in this paper. In particular, the coefficient of this variable is positive and significant in the 2001 letter, but positive and in significant in the 1991 letter.

starts and housing permits are highly correlated, and using either one of them generates similar results.

Party is a dummy variable coded as “1” for democrats. Since Democrats are supposedly more protective of labor than Republicans and put more emphasis on “fair trade,” the coefficient on the Party variable is expected to have a positive sign. Years is the number of years since a Senator was first elected as a Senator and thus serves an approximation of the seniority and power of the Senator as well as the likelihood of being captured by interest groups that seek political support. Thus, the coefficient on Years is expected to have a positive sign. The variable Finance reflects whether the Senator served (at the time the letter to the President was signed) on the Finance Committee, which has jurisdiction over international trade. The predicted sign for the Finance variable is ambiguous. On one hand, Senators on the Finance Committee who prefer free trade generally may not want to sign the softwood lumber letters that restrict free trade. On the other hand, Senators on the Committee who want to get something back from the President in the context of international trade negotiations could threaten or implicitly pressure the President by sending him the letters. Data for Party, Years, and Finance were collected from the *Congressional Quarterly Almanac* for the respective years.

LCV Score is a voting index, which represents the percent of time each member has voted with the so-called “environmental agenda.” Since the Coalition for Fair Lumber Imports has succeeded in portraying the softwood lumber trade with Canada as having environmental implications and thereby gaining support from some environmental groups, the coefficient on the LCV Score variable is expected to have a positive sign. Data for this variable was collected from League of Conservation Voters website (<http://www.lcv.org/scorecard/archive.asp>).

Finally, the variable Border is used as an approximation of other trade conflicts with Canada. States bordering with Canada often produce similar products with Canadian provinces—whether it is wheat and cattle in Montana and North Dakota, auto parts in Michigan, forest products in Washington, Idaho, or Maine, or printing media products in New York. Over the years, when the U.S. has had trade disputes with Canada in wheat, auto parts, forest products, and printing media products, Senators from these states have undoubtedly also asked Senators from other states for support. In the case of the softwood lumber dispute, it seems plausible that Senators from these states will be supportive of the U.S. lumber industry, even though these states may not be large lumber producers. The Border variable serves as an indicator of logrolling in the U.S. Senate and is expected to have a positive sign.

Empirical Findings

Table 1 lists descriptive statistics for the dependent and independent variables in the two models. As Party and LCV Score are highly correlated in both years (0.5659 in 1991 and 0.8161 in 2001), we decided to drop the LCV Score variables from the equations, although the results with LCV Score variable instead of Party are similar to these reported here. The three variables—Lumber Production, Lumber Production Rank, and Top 20 Producer—measure similar things and thus also are highly correlated. Accordingly, we ran individual regressions with each one of them and report the results separately. Log-likelihood ratio tests for each of the models are significant at the 1 percent level.

The results for the 1991 letter are reported in Table 2. The coefficients for the variables that measure producer influence have the expected signs, and all of them—Lumber Production, Lumber Production Rank, and Top 20 Producer—are significant at the 10 percent level or better in the separate models. The coefficient for the Softwood Volume Per Capita variable is positive

Table 1. Descriptive statistics for dependent and independent variables

Variables	Letter in 2001		Letter in 1991	
	Mean	S.D.	Mean	S.D.
Letter	0.50		0.66	
Lumber Production	675.55	1278.49	721.27	1360.75
Lumber Production Rank	25.50	14.50	25.50	14.50
Top 20 Lumber Producer	0.40		0.40	
Softwood Volume Per Capita	18.80	44.21	19.27	45.79
Building Permit	32.72	37.57	18.97	20.97
Party	0.51		0.57	
Years	11.36	10.00	11.26	8.00
Finance	0.21		0.20	
Border	0.22		0.22	

Table 2. Logit estimates for the 1991 Senate letter to the President on softwood lumber

Variables	Model I		Model II		Model III	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Lumber Production	0.0006*	1.794				
Lumber Production Rank			-0.0589***	-2.897		
Top 20 Lumber Producer					1.5456**	2.501
Softwood Volume Per Capita	-0.0031	-0.344	-0.0030	-0.367	-0.0018	-0.203
Building Permit	-0.0385**	-2.507	-0.0401***	-2.806	-0.0367***	-2.634
Party	-1.2736**	-2.390	-1.2028**	-2.154	-1.3015**	-2.360
Years	-0.0466	-1.541	-0.0433	-1.394	-0.0427	-1.378
Finance	-0.2075	-0.334	-0.2625	-0.416	-0.3335	-0.532
Border	1.3008 [†]	1.626	1.2959 [†]	1.626	1.4740*	1.863
Constant	2.2979***	3.183	4.2140***	3.870	2.0340***	2.760
No. of observations	100		100		100	
Log-likelihood	-52.7027		-50.0615		-51.1519	
Restricted log-likelihood	-64.1036		-64.1036		-64.1036	
Chi-Squared value	28.0160***		28.0840***		25.9033***	

*, **, and *** indicate significance at 10, 5, and 1% levels.

[†] Significant at 10.4 percent

but insignificant. Not surprisingly, the coefficient for the variable measuring the influence of home builders—Building Permit—is negative and significant at the 1 percent level in all three models as well. One variable measuring ideological characteristics of the Senator—Party—is negative and significant in all three models. The coefficients for the other two variables (Finance and Years) are insignificant. The coefficient for the Border variable is positive and significant at about the 10 percent level in all three models.

The results for the 2001 letter, reported in Table 3, are largely similar to the results for the 1991 letter. Again, the coefficients for all four measures of the importance of softwood lumber from a production standpoint have the expected signs, and two of them—Lumber Production Rank, and Top 20 Producer—are significant at the 10 percent level or better. The coefficient for the fourth variable—Softwood Volume Per Capita—is positive and highly significant in all three models. The coefficient for the variable measuring the influence of home builders—Building Permit—has the expected (negative) sign in all three models and is

Table 3. Logit estimates for the 2001 Senate letter[†] to the President on softwood lumber

Variables	Model I		Model II		Model III	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Lumber Production	0.0004	0.870				
Lumber Production Rank			-0.1271***	-3.028		
Top 20 Lumber Producer					1.4848*	1.701
Softwood Volume Per Capita	0.3886***	4.299	0.2180**	2.235	0.3639***	4.045
Building Permit	-0.0016	-0.199	-0.0213*	-1.822	-0.0096	-0.952
Party	1.2921*	1.746	1.3008*	1.665	1.4140*	1.852
Years	0.0606*	1.920	0.0639*	1.781	0.0562*	1.747
Finance	-0.2615	-0.320	-0.1150	-0.131	-0.3191	-0.393
Border	1.4481*	1.701	1.2178	1.234	1.2864	1.412
Constant	-3.6048***	-3.650	1.1596	0.674	-3.5480***	-3.600
No. of observations	100		100		100	
Log-likelihood	-34.7079		-29.7827		-33.6163	
Restricted log-likelihood	-69.3147		-69.3147		-69.3147	
Chi-Squared value	69.2137***		79.0640***		71.3968***	

*, **, and *** indicate significance at 10, 5, and 1% levels.

[†]One signature in letter could not be deciphered affirmatively. We had to treat this signatory as a non-signatory in this analysis.

significant at the 10 percent level in one of the three models. Two variables measuring the characteristics of the Senator—Party and Years—have the expected signs and are significant at the 10 percent level in all three models. The coefficient for the Border variable has a positive sign in all three models and is significant at the 10 percent level in one of the model. The coefficient for the Finance variable is negative and insignificant.

In order to measure the performance of the models in predicting whether or not each Senator would have signed the 1991 and 2001 letters, the percentage of correct predictions based on the first sets of estimates for each letter are reported in Table 4. For example, in the case of the 1991 letter, the model correctly predicts 74 (15+59) of the 100 outcomes, an overall success of 75 percent. Comparing the two specific outcomes, the model correctly predicts 44 percent of the “no” signatures and 89 percent of “yes” signatures. In the case of the 2001 letter, the model correctly predicts 88 percent of the outcomes, performing well in both specific outcomes.

To further demonstrate the explanatory power of the model, another measure is presented in the rightmost column of Table 4. The numbers in this column show the randomly assigned ratios of “yes” and “no” signatures. That is, if there were no explanatory variables and outcomes were assigned according to the actual ratios, 34 percent of the “no” signatures and 66 percent of the “yes” signature will be correctly predicted in the 1991 letter. Comparing these numbers to those in the percent correct column demonstrates the increase in the explanatory power of the model due to the addition of the independent variables. It is evident from the comparison that our ability to predict the pattern of signatures is greatly enhanced by the addition of the independent variables for the 2001 letter while the marginal predictive enhancement of the model, relative to the 1991 letter, is more modest. A possible explanation for the 1991 results is that the “crisis” is prompted by a Canadian “unilateral withdrawal” from the MOU and some Senators who would not have signed the letter otherwise might be compelled to show their will against (no-voting) foreigners and foreign governments.

Table 4. Predicted versus actual outcomes using the first sets of estimates

1991 Letter					
Actual	Predicted outcomes			% Correct	% Random assignment
	0	1	Total		
0	15	19	34	44	34
1	7	59	66	89	66
Total	22	78	100		
2001 Letter					
Actual	Predicted outcomes			% Correct	% Random assignment
	0	1	Total		
0	45	5	50	90	50
1	7	43	50	86	50
	52	48			

CONCLUSIONS AND DISCUSSION

This paper uses a roll call analysis to analyze the determinants of U.S. Senators' willingness to sign a letter to the President pressuring him to find an acceptable solution to the U.S.-Canada softwood lumber trade dispute that protects the domestic lumber industry. The results indicate that the economic significance of the lumber and of the housing industries in a state, the Senators' party affiliation and years of services in the U.S. Senate, and logrolling influence Senators' decisions to exert pressure on the President in this manner. Senators clearly were responsive to important, timber or housing construction related interest groups.

More generally, our findings are consistent with the interest group theory of political decision-making. A small but concentrated softwood lumber industry can successfully lobby their elected officials such as Senators and demand protection from foreign competition, despite the fact that such protectionism harms the economic welfare of the nation as a whole (Wear and Lee 1993; Zhang 2001). In the two cases we analyzed, Senators from lumber producing states, along with the support of a number of their colleagues from other states, built sizable coalitions that encompassed a majority of the Senate. The implicit pressure and demand for action could not lightly be ignored by the President. In the cases we analyzed, they were not ignored by the President.

We have demonstrated that the roll call analysis could be applicable to a Congressional letter. In addition, we have found that years of services in the Senate could influence a Senator's political behavior, heretofore not seen in the literature. Our results can be used in identifying the possible supporters and opponents of particular international trade policies. However, without knowing the movers and shakers behind the scene, it may be difficult to distinguish "logrollers" from a core group of Senators who are influenced by and received support from the particular special interest groups. Further studies can be done in this area.

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