Forestry:

Economics and Environment

Proceedings of the
Southern Forest Economics Workshop 2005

April 18-20, 2005
Baton Rouge, LA

Editors:

Sun Joseph Chang
School of Renewable Natural Resources

Mike A. Dunn
Department of Agricultural Economics
and Agribusiness
Louisiana State University Agricultural Center

Preface

These are the Proceedings of the 35th Annual Southern Forest Economics Workshop, held at the Marriott Hotel in Baton Rouge, Louisiana on April 18-20, 2005. The workshop was jointly sponsored by the School of Renewable Natural Resources and the Department of Agricultural Economics and Agribusiness, Louisiana State University Agricultural Center.

SOFEW 2005 focused on the interplay and balance of forestry between economics and environment and included sessions on economics of forestry operations, certification, economics of forest products industry, recreation, poverty and deforestation, laws and regulations, financial economics, regional economics, forest taxation, fire economics, and public forestry programs. The wide varieties of topics are testimonies to the vitality of forest economics research in the South. Furthermore, we had the pleasure of our friends from Finland to present a paper at the workshop. The attendees were treated to 41excellent papers. We would like to thank all the presenters for their fine presentations and to participants for their valuable comments on the presentations. Without the active involvement of all, the workshop would not have been a success.

We also like to thank Bob Blackmon, Director, School of Renewable Natural Resources for his welcome address and passionate plea for forest economists to pay attentions to matters other than timber. Special thanks are due Chris Zinkhan, President of the Forestland Group and Jeffrey Williams, Manager of Environmental Affairs of Entergy Corporation for their keynote addresses. Chris' presentation on how TIMOs innovate to capture more value from forestland and Jeff's presentation on what Entergy is doing in carbon sequestration are truly enlightening. After the meeting, attendees visited the beautiful Zemurray Gardens, the crown jewel of a 5500 acre non-industrial private forest is managed by Bennett and Peters for timber production, hunting, fishing, and recreation in general and were treated to the Louisiana special -- crawfish boil.

We should also hasten to thank the following moderators, Bruce Carroll, Fred Cubbage, Jack Lutz, Bill Luppold, Steverson Moffat, Ian Munn, Matt Pelkki, Jeff Prestemon, Erin Sills, and Chris Zinkhan, for running the concurrent sessions on time.

As with any successful conference, much of the burden and credit goes to people behind the scene. The folks at Mississippi State University set up the web page for online registration and registration in general. We specifically want to thank three graduate students -- Francisco Aguilar, James Henderson, and Nianfu Song for handling many of the logistical details. Without their help, the workshop would not have been possible. Finally, we want to thank all authors and coauthors for submitting quality manuscripts. After Hurricanes Katrina and Rita keeping busy seems to be the antidote needed to deal with the ensuing chaos and stresses.

Sun Joseph Chang
Mike A. Dunn
February, 2006

Table of Contents

Concurrent Session 2B: Laws and Regulations

Concurrent Session 2C: Financial Economics

Concurrent Session 3A: Economics of Forest Products Industry

Concurrent Session 3B: Regional Economics

Concurrent Session 4A: Fire Economics I

Concurrent Session 1A: Economics of Forestry Operations

Forest Management Plan Implementation: The Economic Implications of Straying from the Optimal Strategy

Bruce Carroll [1]
Eric Cox [2]
Ian Prior [3]

[1] President & CEO – FORSight Resources, LLC. 8761 Dorchester Rd, Suite 101, North Charleston, SC 29420 USA, (843) 552-0717, Bruce.Carroll@FORSightResources.com
[2] Forest Planner – FORSight Resources, LLC. 8761 Dorchester Rd, Suite 101, North Charleston, SC 29420 USA, (843) 552-0713, Eric.Cox@FORSightResources.com
[3] Forest Planner – FORSight Resources, LLC. 271 West Broadway, Bangor, Maine, 04401 USA, (207) 945-3302, Ian.Prior@FORSightResources.com

Forest Management Plan Implementation: The Economic Implications of Straying from the Optimal Strategy

Abstract

Increasingly investors are using sophisticated computer modeling techniques to formulate forest management plans. Optimization modeling techniques are gaining in popularity because they allow the exploration of management alternatives and provide an optimal solution. As investor sophistication grows models incorporate more and more detailed geographic information system (GIS) data, inventory data, and biometric assumptions. Biometric models, that provide growth and yield assumptions for optimization models, now include treatment responses allowing the ability to model intensive silviculture directly represented by data rather than simple multipliers (as was common in the past). The goal of these sophisticated models is to improve financial returns for investors. Improved financial returns, however, may be compromised if an optimal plan is not implemented.

To examine the sensitivity of financial returns, three common forest management plan implementation methods were investigated. Impacts on financial returns were calculated using 1) 'rules of thumb' to guide implementation, 2) current harvesting practices even while silviculture intensity is increasing, and 3) implementation rules addressing only the broadest intent of a plan. It is shown that varying from the optimal plan can have significant consequences in future volumes, revenues and net present value.

Keywords: forest management plan, modeling, optimization, financial return.

1 Introduction

The process of harvest scheduling has changed significantly over the past 20 years. Early planning processes involved area based or volume based calculations of harvest information dealing with timber objectives only. It was not uncommon to conduct a harvest scheduling exercise for very large forest tracts using aggregated strata and yield tables to represent the range of forest types and silviculture in current practice. Little effort was made to look at alternative management regimes or ranges of silvicultural intensity beyond those regimes that were currently in practice. The harvest scheduling exercise produced an allowable cut figure and with such averaged input information, it was reasonable that foresters would use the resulting harvest schedule only as a rough guide during implementation.

More complex planning requirements, the availability of highly detailed GIS and inventory systems, and the advent of fast computers and more robust planning tools have led to comprehensive forest plans that go beyond just calculating harvest levels. Forest management plans now involve managing for multiple objectives including wood flow, cash flow, ecological, and wildlife objectives. Far greater detail goes into the models, often employing stand-level inventory and yield information. These models evaluate a large variety of alternatives in selecting the appropriate silvicultural intensity and set of management regimes that maximize present net value or other management objectives.

With improvements in data and planning models over the recent past, one would expect forest managers would have increased trust in the results of these models. However, many continue to follow historic rules of thumb, or continue to use current practices, even when models indicate otherwise. Others follow the very broadest intent of the forest plan by using aggregated information on harvest volumes and/or cash flows to guide their implementation. This paper will demonstrate how deviation from calculated planning results can lead to reduction in financial returns from managing forest land. We will investigate common implementation methods used by forest managers and illustrate that significant reduction in volume and financial returns can occur as a result of failures to implement the optimal forest management plan.

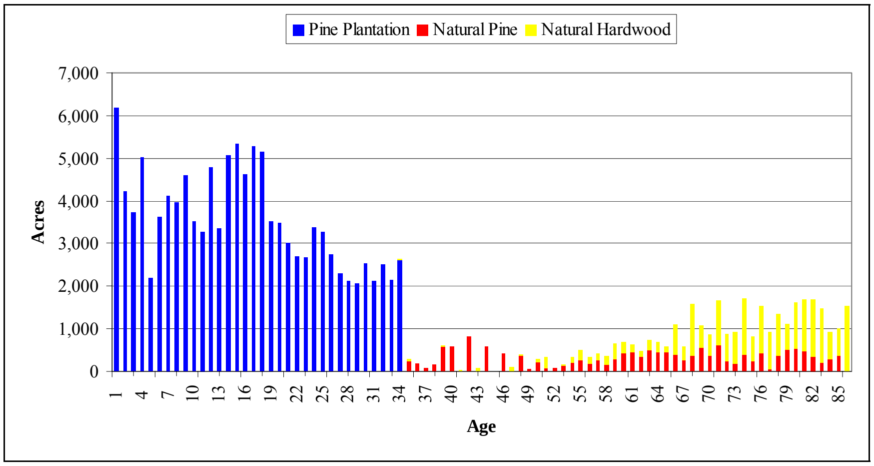
2 Methodology

2.1 Forest Dataset

A South Carolina National Forest database served as the foundation for the simulated forest used in this analysis. Significant alterations to the National Forest database, totaling 158,971 acres in size, were made so that it would better represent a managed industrial forest.

The simulated forest was categorized into 117,496 acres of pine plantation, 22,055 acres natural hardwood, 15,758 acres of natural pine, 2,181 acres of site preparation, and 1,481 acres of cutover stand conditions. A portion of the forest was also categorized a having been thinned, 19,080 acres or 12% of the total area. Each of the 3,588 forest stands was assigned an age, with the initial age-class distribution (Figure 1) representing conditions common to the industrially managed timberlands in the SE USA.

Figure 1: Initial age-class distribution, by forest type, assigned to the simulated forest.



The simulated forest was categorized into 9 site index classes ranging from 50 to 100 feet at 25 years. The distribution of site classes by acreage is detailed in Table 1.

Table 1: Distribution of site class by acreage.

Site Index (@25 years)	**Acres**	**% Acres**
50	146	0.1%
60	7,660	4.8%
65	10,580	6.7%
70	59,553	37.5%
75	27,774	17.5%
80	32,776	20.6%
85	10,669	6.7%
90	7,685	4.8%
100	2,127	1.3%
Total	**158,971**	

Ten categories of trees per acre (TPA) were assigned, with 49.6% or 78,850 acres having TPA's equal to or greater than 300. The distribution of TPA by acreage is detailed in Table 2.

Table 2: Distribution of trees per acre (TPA) by acreage.

TPA	Acres	% Acres
<100	32,404	20.4%
100-149	9,279	5.8%
150-199	422	0.3%
200-299	38,032	23.9%
300-399	15,666	9.9%
400-499	11,670	7.3%
500-544	5,309	3.3%
545-599	34,023	21.4%
600-699	9,372	5.9%
700+	2,794	1.8%
Total	**158,971**	

A biometrics analysis divided the simulated forest into 588 strata. These strata were then grown using a propriety growth and yield model specific to the Southeast USA. This analysis included growth and yield responses for mid-rotation fertilization with and without thinning.

Products merchandised for this analysis included pine pulpwood, pine topwood, pine Chip 'n' Saw, pine sawtimber, hardwood pulpwood, and hardwood sawtimber. The starting inventory for this analysis is detailed in Table 3. On average the volume of pine stands was 70.7 tons/acre and the volume of hardwood stands was 117.6 tons/acre.

Table 3: Starting inventory of the simulated forest (tons).

Product	Volume (tons)
Pine pulpwood	2,781,312
Pine topwood	95,047
Pine Chip 'n' Saw	3,231,356
Pine Sawtimber	3,310,441
Pine Sub-Total	**9,418,156**
Hardwood pulpwood	753,380
Hardwood sawtimber	1,839,189
Hardwood Sub-Total	**2,592,569**
Pine + Hardwood Total	**12,010,725**

2.2 Base Model (Base)

A strategic model was formulated utilizing the *Woodstock* forest modeling system (utilizing Model-II linear-programming optimization techniques) for the simulated forest. This *Base* model was also used to derive four alternative model formulations representing various strategic plan implementation techniques. The Base model included a number of assumptions, including;

1. Only even-aged forest management was employed.
2. Silviculture included site preparation, plantation establishment, and fertilization.

3. Harvesting included thinning and final harvest (clearcut). All thinnings received a post thinning fertilization application. Thinning was permitted between the ages of 14 and 20. Final harvest was permitted on stands 20 years of age and greater.
4. An 8% real discount rate was used for financial analysis (net of inflation).
5. Financial assumptions were considered pre-tax.
6. An objective function maximized NPV over a 100-year model horizon, with 1-year period intervals. Only the first 50-years of the planning horizon were used for reporting, with longer planning horizons used in the model to eliminate artifacts due to "end of planning horizon effects" that are common to all planning models.
7. A sequential flow constraint (+/- 20%) was placed on the pine volume (top wood, pulpwood, Chip 'n' Saw, and saw timber) harvested. The amount of pine harvested could increase or decrease by as much as 20% from one period (year) to another.
8. A sequential flow constraint (+/- 20%) for acreage 30 years or greater cut in years 1 to 8. The amount of final harvest acres could increase or decrease by as much as 20% from one period (year) to another.

2.3 Alternative Models (HYld, Rule 1, Budget, and Rule 2)

Four alternative models were developed to represent implementation of the Base model 'on the ground' or operationally. These alternatives quantify the consequences of deviating from an optimal solution through various implementation techniques. To mimic various implementation techniques, several Base model assumptions were altered, the model re-run and results reported. Each alternative model is described below, including the implementation technique each represents.

2.3.1 Alternative 1 – Harvest Highest Yielding First (HYld).

This model alternative involved two modeling steps. First, the Base model solution was used as input to a simulation model. This simulation model forced harvesting of the highest yielding strata for the first 20 years, while at the same time maintaining the annual harvest volume reported by the Base model. Second, the 20-year solution provided by the simulation model was incorporated into the Base model and re-run to obtain the balance of the solution for years 21-100. This alternative was meant to mimic the implementation of a strategic plan where the 'best' or highest yielding harvest blocks are favored over lower yielding harvest blocks.

2.3.2 Alternative 2 – Applying a 'rule of thumb' (Rule1)

This model alternative applied a 'rule of thumb' to harvest implementation. The Base model allows final harvest at 20 years of age and greater. In this alternative, the following 'rule of thumb' was applied: final harvesting was only allowed between 23-25 years of age from year 9 to the end of the 100-year planning horizon. In addition, while the Base model stipulates thinning between 14-20 years of age, the 'rule of thumb' for this alternative allows a narrower thinning window of 14-16 years of age. This alternative is meant to mimic management where the foresters believe that similar management should occur regardless of other important stand conditions such as site index, basal area, or trees per acre.

2.3.3 Alternative 3 – Silviculture Budget Constrained (Budget)

This model alternative restricted silviculture expenditures in order to represent real world budget constraints. Only 75% of the silviculture expenditure per year in the Base model was permitted for the first 20-years. Silviculture expenditures were applied at 100% of the Base model levels beyond 20 years. This is meant to mimic the somewhat common situation where silviculture budgets were reduced for a period of time.

2.3.4 Alternative 4 – Applying a 'rule of thumb' (Rule2)

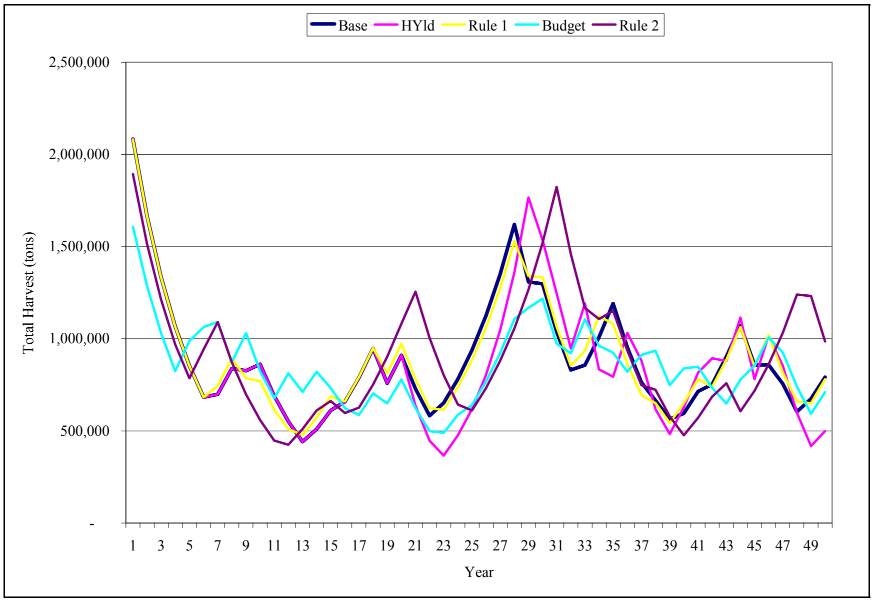
This model alternative applied a 'rule of thumb' to harvest implementation. The Base model allows final harvest at 20 years of age and greater. In this alternative, the following 'rule of thumb' was applied: final harvesting was only allowed between 26-28 years of age from year 9 to the end of the 100-year planning horizon. In addition, while the Base model stipulates thinning between 14-20 years of age, the 'rule of thumb' for this alternative only allows a thinning window of 16-18 years of age. These thinning and final harvest timings are outside the optimal range in the base model. This alternative is meant to mimic management where foresters continue to manage the way they historically have even while planting better genetic material and use improved silvicultural practices.

For clarity and ease of understanding each model has been provided a name. The Base model will simply be referred to as *Base*. The alternative models are named according to their implementation technique; Alternative 1 is named *HYld***,** Alternative 2 is named *Rule 1*, Alternative 3 is named *Budget*, and Alternative 4 is named *Rule 2*.

3 Results and Discussion

Harvest volumes over 50 years for the Base model and the four alternative models are illustrated in Figure 2. Variations in harvest volume are evident when comparing the four alternative models to the Base model. The total harvest volume over 50 years for the Base model was 44.6 million tons; the alternative models varied in totals from 42.7 to 45.8 million tons, a -1.9 to +1.2 million tons variation range. If distributed equally over 50 years, this variation equates to -37,976 to 23,270 tons per year.

Figure 2: 50-Year harvest volumes for the Base model and four alternative models (HYld, Rule 1, Budget, and Rule 2).



When harvest volume is examined over years 1-25 versus 26-50 it is evident that variation in total harvest volume over the total 50-years is influenced by timing of harvest (Table 4). Alternatives HYld, Rule1, and Budget show considerably more variation in years 1-25 than 26-50.

Table 4: Total harvest volume (tons) for years 1-25 and 26-50. Variation from Base and the variation of harvest volume per year (distributed evenly over 25 years) are calculated.

	Years 1-25			Years 26-50		
Model	**Harvest Volume**	**Variation from Base**	**Variation Per Year**	**Harvest Volume**	**Variation from Base**	**Variation Per Year**
Base	***21,460,124***			***23,146,039***		
HYld	20,322,176	-1,137,948	-45,518 (-5.3%)	23,030,722	-115,317	-2,306 (-0.2%)
Rule 1	21,556,402	1,234,226	49,369 (5.8%)	23,241,047	210,325	4,207 (0.5%)
Budget	20,549,685	-1,006,717	-40,269 (-4.7%)	22,157,700	-1,083,347	-21,667 (-2.3%)
Rule2	21,458,998	909,312	36,372 (4.2%)	24,310,650	2,152,951	43,059 (4.7%)

Variance of harvest volume from the Base is illustrated in Figure 3 for years 1-25. Harvest volumes vary significantly year to year from the Base depending on the alternative. The Budget model alternative variance peaks at year 7 at 392 thousand tons more than Base. The Rule 2 model alternative peaks at year 21 at 526 thousand tons more than Base. The HYld model alternative variance is negligible until year 20 beyond which harvest volume decreases 319 thousand tons by year 25. This is not unexpected considering the HYld alternative focused on matching the Base model harvest volumes over the initial 20 years.

Figure 3: Harvest volume variance of four alternative models (HYld, Rule 1, Budget, and Rule 2) from Base harvest volume for years 1-25.

Final harvest acres over 50 years for the Base model and the four alternative models are illustrated in Figure 4. Acres of final harvest vary from year to year as the different implementation techniques are employed in each alternative model. The HYld and Rule 2 alternative models show the greatest one year variance, +3,844 acres at year 7 and -4,733 acres at year 9 respectively (Figure 5).

Figure 4: Acres of final harvest for Base and four alternative models (HYld, Rule 1, Budget, and Rule 2) for years 1-50.

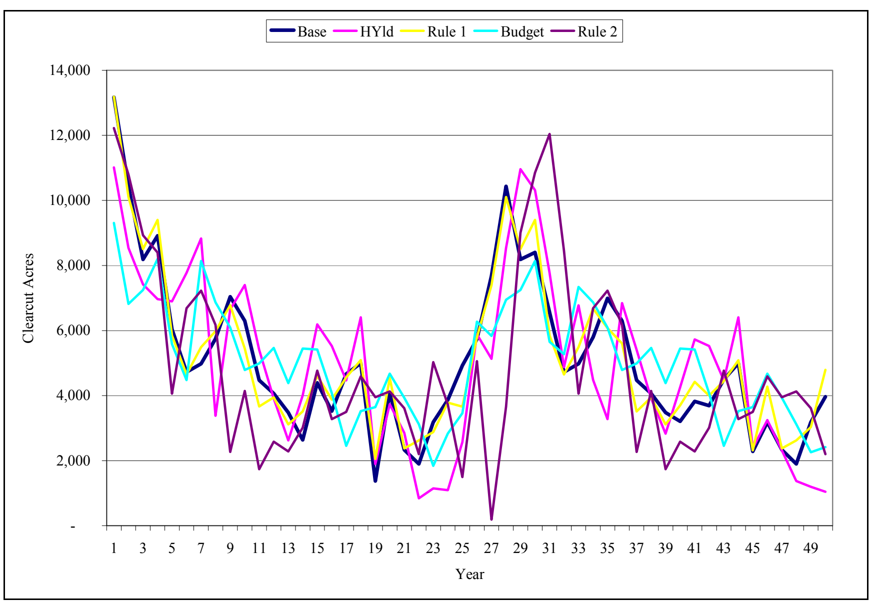
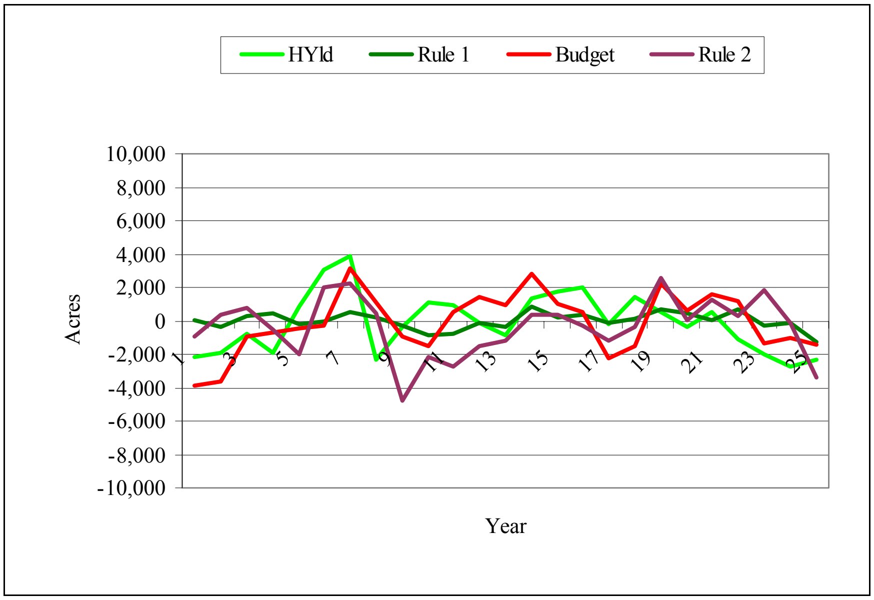


Figure 5: Final harvest acres variance of four alternative models (HYld, Rule 1, Budget, and Rule 2) from Base final harvest acres.



Acres of thinning vary significantly from year to year as the different implementation techniques are employed in each alternative model (Figure 6). The Budget and HYld alternative models show the greatest one year variance, -8,148 acre at year 2 and +8,540 acres at year 8 respectively (Figure 7).

Figure 6: Thinning acres of four alternative models (HYld, Rule 1, Budget, and Rule 2) from Base thinning acres.

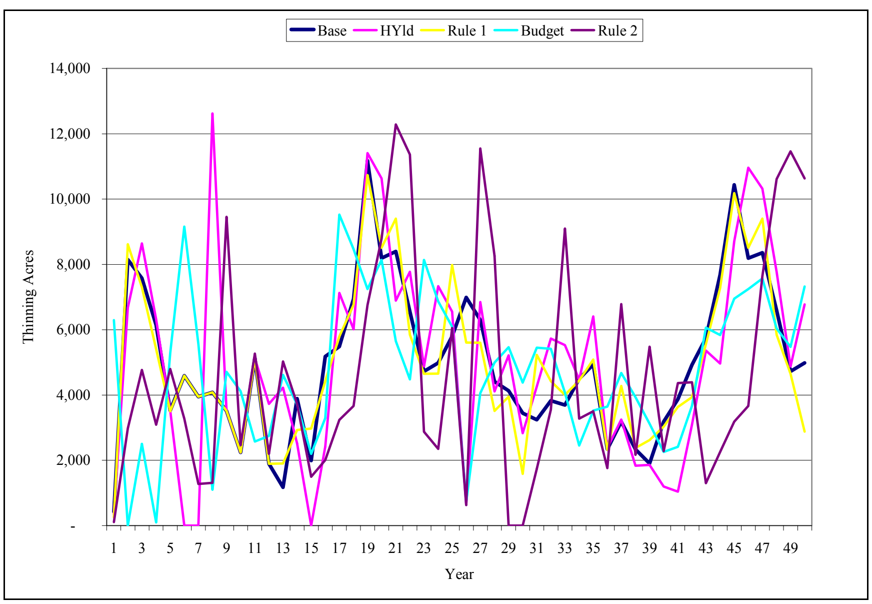
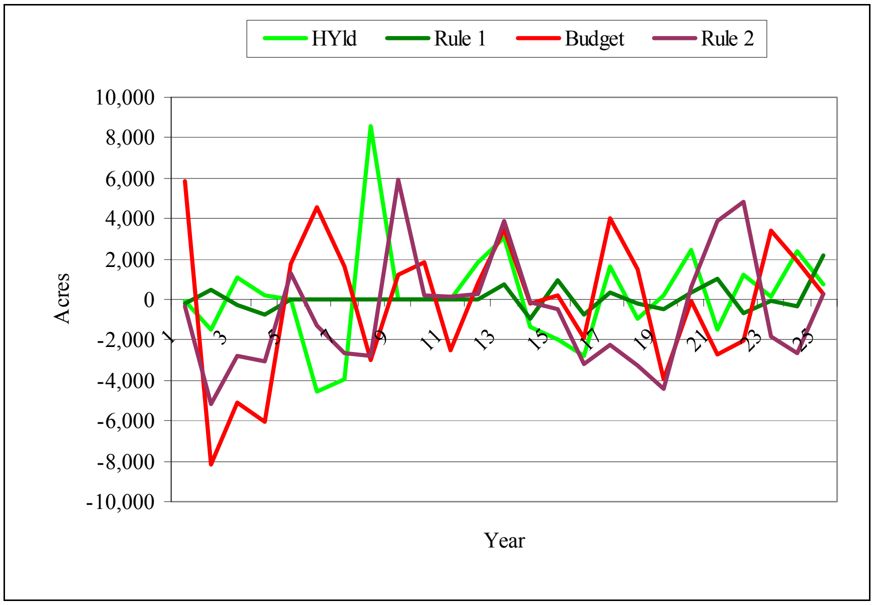


Figure 7: Thinning acres variance of four alternative models (HYld, Rule 1, Budget, and Rule 2) from Base thinning acres.



The average annual pine harvest volume (tons) for years 1-20 and years 1-50 for the Base and the four alternative models are listed in Table 5.

Table 5: Average annual pine harvest volume (tons) for years 1-20 and years 1-50 for Base and four alternative models.

		Years 1..20			
tons	***Base***	**HYld**	**Rule 1**	**Budget**	**Rule 2**
Pine Sawtimber	***334,853***	301,316	338,295	361,133	339,296
Pine Chip 'n' Saw	***285,400***	307,130	287,390	273,141	272,418
Pine Pulpwood	***268,692***	280,495	270,243	251,300	245,466
Total	***888,945***	888,940	895,929	885,575	857,180

		Years 1..50			
tons	***Base***	**HYld**	**Rule 1**	**Budget**	**Rule 2**
Pine Sawtimber	***409,121***	373,979	412,271	356,327	433,444
Pine Chip 'n' Saw	***212,472***	223,487	214,307	246,790	210,149
Pine Pulpwood	***270,530***	269,592	269,370	251,031	271,800
Total	***892,123***	867,058	895,949	854,148	915,393

Some relevant observations of the average annual pine harvest volumes when compared to the Base include:

1. HYld shows a loss in harvest volume of 4.4% in years 21-50, and 2.8% across years 1-50.

2. HYld shows less sawtimber with a 10.0% reduction over years 1-20 and an 8.6% reduction over years 1-50.
3. Rule1 shows a very similar harvest and product mix to the Base model.
4. Budget shows a loss in harvest volume over years 1-50 with a 4.3% reduction in total harvest and a 12.9% reduction in sawtimber. The reduction in silviculture spending causes a reduction in volume in later years, especially sawtimber volume.
5. Rule 2 shows slightly lower harvest volumes for years 1-20 with a 3.6% reduction, and slightly higher volumes across years 1-50 with a 2.6% increase.

The average annual harvest acres for years 1-20 and years 1-50 for the Base and the four alternative models are listed in Table 6.

Table 6: Average annual harvest acres for years 1-20 and years 1-50.

			Years 1..20		
acres	***Base***	**HYld**	**Rule 1**	**Budget**	**Rule 2**
Thinning	***4,762***	4,854	4,725	4,566	3,784
Final Harvest	***5,662***	5,952	5,719	5,580	5,237
Total	***10,424***	10,805	10,443	10,146	9,021

			Years 1..50		
acres	***Base***	**HYld**	**Rule 1**	**Budget**	**Rule 2**
Thinning	***4,992***	5,018	4,940	4,786	4,604
Final Harvest	***5,087***	5,050	5,138	5,060	4,805
Total	***10,079***	10,068	10,078	9,846	9,409

Some relevant observations of the average annual harvest acres when compared to the Base include:

1. HYld shows slightly more harvest acres for years 1-20; however, total harvest acreage is almost identical over years 1-50.
2. Rule 1 shows almost identical harvest acres and harvest timing over years 1-50.
3. Budget shows lower harvest acres during years 1-20 with a 2.7% reduction. Harvest acres are also lower over years 1-50 with a 2.3% reduction.
4. Rule 2 shows less harvest acres over years 1-20 with a 13.5% reduction. Thinning acres are reduced by 20.5%, and final harvest acres are reduced by 7.5% over years 1-20.
5. Rule 2 shows less harvest acres over years 1-50 with a 6.6% reduction. Thinning acres are reduced by 7.8%, and final harvest acres are reduced by 5.5% over years 1-50.

The total and per acre net revenues for years 1-20 and years 1-50 for the Base and the four alternative models are listed in Table 7.

Table 7: Total and per acre net revenues for years 1-20 and years 1-50.

	Years 1..20				
	Base	**HYld**	**Rule 1**	**Budget**	**Rule 2**
Net Revenue (millions)	***$391***	$376	$396	$420	$389
Net Revenue/Acre	***$2,462***	$2,368	$2,489	$2,640	$2,444
Percent Loss		3.8%	-1.1%	-7.2%	0.7%

	Years 1..50				
	Base	**HYld**	**Rule 1**	**Budget**	**Rule 2**
Net Revenue (millions)	***$1,024***	$969	$1,033	$979	$1,069
Net Revenue/Acre	***$6,444***	$6,098	$6,497	$6,155	$6,724
Percent Loss		5.4%	-0.8%	4.5%	-4.3%

Some relevant observations of the total and per acre net revenues when compared to the Base include:

1. HYld shows lower revenue in years 1-20 with a 3.8% reduction. Lower revenue is also evident over years 1-50 with a 5.4% reduction. Both of these reductions are due to less favorable product mix.
2. Rule 1 shows a net revenue increase over years 1-50 of 0.8%.
3. Budget shows net revenues increase 7.2% in years 1-20 due to lower spending on silviculture, however, net revenues decrease 4.5% over years 1-50 as a consequence of not spending as much on silviculture in the early years.
4. Rule 2 shows net revenue marginally lower in years 1-20 by 0.7%, however, over years 1-50 net revenue increases 4.3%. This increase is due to longer rotations yielding an improved product mix in the later periods.

The total and per acre Net Present Value (NPV) for years 1-20 and years 1-50 for the Base and the four alternative models are listed in Table 8.

Table 8: Total and per acre NPV for years 1-20 and years 1-50.

	Years 1..20				
	Base	**HYld**	**Rule 1**	**Budget**	**Rule 2**
NPV (millions)	***$235***	$228	$235	$239	$229
NPV/AC	***$1,477***	$1,432	$1,480	$1,503	$1,438
Percent Loss		3.0%	-0.2%	-1.8%	2.6%

	Years 1..50				
	Base	**HYld**	**Rule 1**	**Budget**	**Rule 2**
NPV (millions)	***$287***	$275	$287	$282	$283
NPV/AC	***$1,808***	$1,727	$1,808	$1,773	$1,782
Percent Loss		4.5%	0.0%	1.9%	1.4%

Some relevant observations of the total and per acre NPV when compared to the Base include:

1. HYld shows a 3% decrease in NPV over years 1-20, and a 4.5% decrease over years 1-50.
2. Rule 1 shows a 0.2% decrease in NPV over years 1-20 and no net loss over years 1-50.
3. Budget shows a 1.8% increase in NPV over years 1-20, however, NPV decreases 1.9% over years 1-50. This is due to not obtaining the gains from advanced silviculture at the time of harvest of future stands.
4. Rule 2 shows a decrease in NPV of 2.6% over years 1-20, and a 1.4% loss over years 1-50. This shows the negative impact of missing the optimal thinning and timing windows by even a small margin.

4 Conclusions

This analysis attempted to mimic implementation of an optimal strategic plan in a modeling environment. The modeling environment enabled quantifiable variables to be reported, thus demonstrating the implications of deviating from an optimal strategic plan. The results have provided interesting insight into strategic plan implementation.

A predominant observation of this analysis is the sensitivity of a strategic plan to change because all activities in an optimal solution are inherently linked and small deviations in implementing a plan have widespread implications. The various alternative models demonstrated these implications when harvest volumes and acres, revenues and NPV are compared year to year with the Base model. Each alternative model showed significantly different solutions in terms of treatment acreage scheduled each period.

More specifically, some significant conclusions can be draw from the solution results of each specific alternative model.

The HYld alternative model showed a reduction in NPV of 3% over years 1-20 and 4.5% over years 1-50. When implementing a strategic plan scheduling the highest yielding blocks first, the short-term benefits are given very high priority. This implementation technique may result in short-term operational efficiencies (logistical and economic) but the long-term negative implications are evident as indicated in the results. At some point in the future a high concentration of lower yielding harvest blocks will have to be scheduled for harvest. This will result in a reduction of future revenues and may also result in higher harvesting and silviculture costs in the future. Acceptance of this implementation technique depends on the management philosophy of the land manager. One manger may prefer to schedule lower yielding blocks with the higher yielding blocks to distribute the associated higher operating costs over time. Another manager may prefer to harvest the higher yielding blocks first and simply deal with the lower yielding blocks at some point in the future. Either approach may be acceptable if the land manager's long-term goals are achieved. It is when the long-term goals are not achieved that this implementation technique comes into question.

The Rule 1 alternative model showed no impact on NPV over 1-50 years. This suggests there is some flexibility in implementing an optimal strategic plan and that a set of harvest scheduling rules obtained from a robust planning model works well. However, NPV is sensitive to changes in prices, costs, discount rates, and merchandising specifications. As changes occur, this implementation method may be compromised and have greater than expected consequences. This is a primary reason for the periodic nature of strategic plan formulation. Typically, strategic plans are prepared every 3-5 years in order to adjust to changing prices, costs, discount rates, and management regimes. Significant changes to these or other assumptions or parameters may require strategic plans to be updated more frequently.

The Budget alternative model showed a reduction in NPV of 1.9% over 50 years when compared to the Base model. Decreased revenues are a direct result of reduced silvicultural expenditures and lower intensity silviculture, thus negatively impacting the achievement of future financial returns. The short-term gain in revenues in years 1-20, a 1.8% increase in NPV, is simply a result of less spending as harvest levels have essentially remained the same. However, over the long-term, as missed silviculture opportunities would have produced a return on the initial investment, the NPV is reduced.

The Rule 2 alternative model showed that if timing of harvesting is not optimal, NPV can be negatively impacted, in this case a 2.6% reduction over years 1-20 and a 1.5% reduction over years 1-50. For the Rule 2 model, the average final harvest age was only 2 years later and the average thinning age 1 year later than the Base model averages. The alterations to harvest timing and reductions in NPV may seem small; however, when managing a large landbase this may represent a significant dollar amount. For the simulated forest used in this analysis, the reduction in NPV over 25 years was 6 million dollars. The later thinning ages lead to a reduction in thinning as a preferred management activity. On a positive note, these slightly longer rotations actually increase net revenue in later periods. This increase in revenue is a consequence of a change in product mix, as time allows for more high valued products to be produced.

Forest planners who formulate strategic plans do not expect forest managers to follow the plans exactly. Many factors can influence implementation of a strategic plan. Perhaps the most important factor is that the data used as input into strategic models may not be perfect. As a result, some areas scheduled for management may not be viable when the forest manager evaluates the strategic plan. In addition, all strategic plans incorporate many assumptions on revenues and costs which can abruptly change as conditions change. Lastly, markets, weather, and even road access can influence implementation of a strategic plan.

Though some changes are expected and unavoidable in implementing an optimal strategic plan, all changes have consequences. As expected, the more changes one makes the greater the consequences. The HYld alternative model demonstrated this, as it clearly illustrated that selecting choices which have higher short term gains may have unintended future consequences. These consequences create a ‘snowball effect’ impacting harvest flows, harvest acres, and silvicultural activities.

Another risk associated with implementing a strategic plan is being too selective in what to implement. Forest management plans should not be considered a basket of choices from which one chooses only certain activities to implement; all the parts go together as a set. For example, cutting at a level that assumes a given investment in silviculture, but not making that silvicultural investment violates the basic assumptions of the model. The results projected by the model can be significantly impacted by these types of arbitrary deviations, thus leading to considerable financial impact.

Forest managers are using much more sophisticated planning tools than in the past. GIS and inventory data are much more detailed and as data improves model solutions are becoming more and more accurate. Forest managers also have a wide range of silviculture activities at their disposal. Various high intensity silvicultural alternatives are being readily adopted and represented in strategic planning models. Biometrics now involves complicated growth and yield models that can derive site specific responses based on sophisticated stand specific data.

Using sophisticated forest management tools can lead to increased returns to timberland investors. However, the underlying assumptions of these models must not be violated unless truly justified. Arbitrary deviations from an optimal strategic plan, through various implementation techniques, may result in significant loss in NPV, harvest volume, or other forest values.

This analysis has only touched upon the non-spatial consequences of deviating from an optimal strategic plan. Spatial restrictions also have a large impact on optimal harvest allocation. Many spatial, geographically referenced factors, such as adjacency and green-up requirements, can significantly impact what can actually be implemented from a non-spatial strategic plan. The scale of the impact is further influenced by the manner in which a strategic plan is spatially implemented. Results can vary whether spatial resolution is accomplished manually or with the use of computer assisted allocation. Further research is planned to analyze the impact of failing to follow a computer assisted spatial allocation.

The Influence of Species on Site Selection and Timber Removal in West Virginia

William Luppold[1]
and
Delton Alderman[2]
USDA Forest Service

[1] Project Leader, USDA Forest Service, Northeastern Research Station, 241 Mercer Springs Road, Princeton, WV 24740. email: wluppold@fs.fed.us; 304.431.2700 (v); 304.431.2772 (fax)

[2] Research Forest Products Technologist, USDA Forest Service, Northeastern Research Station, 241 Mercer Springs Road, Princeton, WV 24740. email: daldeman@fs.fed.us ; Phone: 304.431.2700 (v); 304.431.2772 (fax)

Abstract –
During the past 50 years, the composition and structure of eastern hardwood forests have been influenced through harvest site selection based on relative species value and selective harvesting of larger diameter trees. In recent years, new markets for hardwood roundwood have emerged possibly changing the type of timber removed. One state in which harvesting practices may have changed is West Virginia, where new industries have created additional roundwood markets. To determine the impact of new and traditional markets on timber removals and residual-stand attributes, we examined roundwood harvests on 28 sites in West Virginia during 2001. The composition of the sample sites generally was not statistically different from overall composition within the state except for yellow-poplar and chestnut oak. More than 21% of the basal area (BA) on the sampled sites was yellow-poplar, nearly twice the proportion of this species' BA statewide. Removals of yellow-poplar and black cherry were greater than those of red and sugar maple, hickory, and American beech. While the demand for yellow-poplar roundwood by multiple users (sawmills, peeler mills, engineered-wood products plants, and split-rail fencing manufacturers) seems to influence harvest site selection, the continuation of diameter-limit cutting and value seems to have the greatest affect on which trees are removed. This pattern of partial harvests favors the regeneration of shade-tolerant species such as red and sugar maple.

Key words – Hardwood markets, forest composition, harvesting, yellow-poplar

Introduction

Harvesting has influenced the composition and structure of eastern hardwood forests though overstory removal and by perturbing regeneration processes (Carvell 1986). In turn, relative species prices influence which stands are harvested and the criteria (e.g., for timber management or diameter-limit cutting) used to determine which trees are removed. Currently, there are large differences in the price of different hardwood species. Black cherry (*Prunus serotina)* and sugar maple *(Acer saccharum)* are higher value species while American beech (*Fagus grandifolia)* is of low value (Hardwood Mark. Rep. 1990-2001). In addition, there has been increased demand for engineered wood products manufactured from low-density hardwoods (Schuler and Adair 2003; Schuler et al. 2001). Understanding the impact of current markets on harvest site and tree selection will provide insight into the composition and structure of future stands

West Virginia is one state in which roundwood markets have changed. By 1997, the state's sawmilling industry was dominated by large mills producing more than 5 million board feet per year. In addition, there were oriented strand board (OSB) mills and two peeler mills (WV, Bureau of Commer. 1997). To determine the impact of these multiple markets on timber removals and residual-stand attributes, we examined 28 harvest sites in West Virginia during 2001. With these data we examined the attributes of sites selected for harvesting and the characteristics of trees removed from these sites.

Markets for West Virginia Hardwoods

The value of individual hardwood species varies considerably and has changed over time. The existence of markets also influences the value of specific portions of the tree (butt log, upper logs, limbs, etc.) that can be merchandized profitably. Therefore, it is useful to examine the markets and value for the 10 most important species (focus species) in West Virginia[1] (Tables 1-2).

Yellow-poplar *(Liriodendron tulipifera)* roundwood is used by several industries in West Virginia. Butt logs are processed by sawmills, smaller diameter logs are peeled for plywood or laminated veneer lumber, or processed into fence rails, and low-grade roundwood is consumed by oriented strand board (OSB) mills. In 2001, yellow-poplar lumber was of relatively low value (Hardwood Mark. Rep. 2001).

Chestnut oak *(Quercus prinus)* roundwood is converted into sawlogs and pulpwood. The price of chestnut oak lumber and white oak *(Q. alba)* lumber usually is the same yet the grade yield from chestnut oak logs is poorer than from white oak logs (Hanks et al. 1980). Chestnut oak can be interchanged for white oak, though the export markets prefer true white oak. There have been periods in which white oaks were considered a higher value species, but white oak were a mid-valued species in 2001 (Hardwood Mark. Rep. 2001).

[1] Based on growing-stock volume (USDA For. Ser. 2004). In 2000, these species comprised 75% of the growing-stock volume for all species and 79% of the growing-stock volume for hardwoods.

Table 1 -- Proportional basal area, average diameter, and percent of grades 1 and 2 hardwood trees in West Virginia compared to trees on sampled sites.

Focus species	Proportion of all live trees greater than 5 inches		Diameter of live trees greater than 5 inches		Proportion of sawtimber in grades 1 and 2[1]	
	Statewide[2]	Sites	Statewide[2]	Sites	Statewide[2]	Sites
	---Percent---		----Inches--		---Percent---	
Yellow-poplar	11.2	21.2[3]	11.41	13.37[3]	52.2	64.3[3]
Chestnut oak	10.2	4.6[3]	10.52	13.44[3]	46.8	23.8[3]
Red maple	10.1	9.8	8.81	8.74	25.0	32.8
White oak	9.7	7.9	10.69	14.00[3]	46.8	50.2
Northern red oak	7.8	9.3	12.76	14.82[4]	61.0	55.0
Sugar maple	7.4	12.4	8.98	8.94	28.0	31.5
Hickory	6.8	7.2	9.10	9.55	37.2	33.2
American beech	4.4	5.5	9.74	12.38[4]	7.2	7.6
Black oak	4.3	5.3	12.19	15.40[4]	53.2	72.6
Black cherry	3.4	2.4	10.44	13.30	45.1	66.8
All trees	NA	NA	9.82	11.26[3]	34.6	49.4[3]

[1] Weighted by basal area.
[2] See USDA For. Ser. (2004).
[3] Significantly different from state average as developed from USDA For. Serv. 2004 at 0.1 probability level for two-tailed test.
[4] Significantly different from state average as developed from USDA For. Serv. 2004 at 0.5 probability level for two-tailed test.

Table 2– Number of sites harvested by harvesting criteria and average change in basal area, average number of markets, and average number of low-grade markets associated with these sites.

Harvest criteria	Number of sites	Average percentage removal of basal area	Average number of markets[1]
Diameter-limit cutting[2]	14	51.9	4.0
Unspecified	6	51.8	3.7
Managed	5	45.5	4.0
Clearcut	3	100	4.3

[1] Includes sawlogs, peeler logs, tie logs, low-grade sawlogs, fence materials, pulpwood, OSB roundwood, alloy chips, and firewood.
[2] Includes one site that was an apparent 18-inch diameter-limit cut.

Red maple *(A. rubrum)* timber is used for lumber production, but this species also has limited use in OSB, pulp, and fence rail production. In the lumber market, red maple is sold as soft maple. In 2001, soft maple was an emerging species in the lumber market having crossed the threshold from a low-value to a mid-value species in the late 1990s .

Northern red oak *(Q. rubra)* is processed into sawlogs, veneer logs, and pulpwood. Red oak has emerged as a high-value species over the last 25 years. The high-value and the lack of regeneration of this species has resulted in cut exceeding growth during the 1989 to 2000 survey cycle (USDA For. Ser. 2004). Black oak (*Q. velutina)* is sold as red oak and is virtually identical to northern red oak when sawn into lumber.

Sugar maple is processed into sawlogs, veneer logs, and pulpwood. Hard maple became increasingly valuable in the 1990s and was a high-value species by 2001.

Hickory species *(Carya spp.)* are used in the production of lumber and paper, but the high density of hickory makes it difficult to process in modern band mills. The value of hickories has increased in recent years despite highly variable wood characteristics, (e.g. color, grain consistency, and bird peck).

American beech can be processed into lumber and pulpwood but its historic low-value and poor grade have resulted in an large growth-to-removal ratio (USDA For. Ser. 2004). Black cherry is a traditional high-value species in the production of lumber and veneer. In recent years black cherry has surpassed black walnut *(Juglans nigra)* as the most expensive species in the U.S. lumber market.

Data Collection

Selection of the 30 harvest sites examined was based on the distribution of primary wood processors in West Virginia. Since the state has three of the USDA Forest Service's Forest Inventory and Analysis Survey Units that differ in species composition, we stratified the sample based on the proportion of sawtimber volume in these regions. Thus of the 30 sites, 12 should be in the Northeastern Unit, 10 in the Southern Unit, and 8 in the Northwestern Unit. To ensure that all potential roundwood markets were represented in each unit, the population of purchasing mills was stratified by product and mill size. Data on mill size were provided by the West Virginia Division of Forestry. We focused on larger mills because small and part-time mills have limited markets and in West Virginia tend to purchase logs rather than stumpage. The final sample was constrained by the number of willing participants and contained 13 sites in the Northeastern Unit, 9 in the Southern Unit, and 8 in the Northwestern Unit. One site in the latter unit was excluded from the analysis because entrance restrictions prevented a full post harvest observation. A second site also was excluded because it was a pine pulpwood harvest.

On each harvest site, five standard 1/5-acre plots were selected randomly from a grid drawn from the area expected to be harvested and merchandized the next day. Before harvest, the diameter and height of all trees equal to or greater than 5 inches in diameter at breast height (DBH) were measured and current and potential future tree grades were determined. Trees that did not meet criteria for grades 1, 2, or 3 were classified as grade 4. Loggers were questioned as to the harvesting criteria they used (management plan, diameter-limit, etc.) as well as the number of markets they used in merchandizing timber. Each plot was revisited immediately after harvest to classify trees as harvested, not harvested, or destroyed during harvest. Because it was difficult to estimate cubic volume for all species without detailed information on cull portions of the trees, we examined the surveyed sites in terms of BA.

Characteristics of Sites Harvested

In Table 1, the composition, diameter, and quality characteristics of growing-stock trees measured on the sample plots are compared to estimates for these characteristics for the entire state as developed for the 2000 forest inventory (USDA For. Ser. 2004). In general, the composition of the sites was not statistically different from the overall composition for West Virginia except for yellow-poplar and chestnut oak. More than 21% of the BA on the sampled sites was yellow-poplar, or nearly twice the proportion of this species' BA statewide (11.2%).[2] By contrast, only 4.6% of the BA on the sample sites was chestnut oak, or less than half of the proportion statewide (10.2%).

The relative volume of yellow-poplar on the survey sites apparently is the result of multiple markets for this species. Peeler logs and OSB logs were merchandized on 82% and 79% of the sites, respectively. The relatively low proportion of chestnut oak on these sites may reflect its tendency to grow on dry upland sites that are not sought out by industry (Burns and Honkala 1990) and the relatively low lumber yield for this species.

The average diameter of growing-stock trees on the sample sites was greater than the average diameter of all similar trees reported in the 2000 West Virginia inventory (Table 1). However, there was some variation to this finding when examining individual species. The shade-intolerant and mid-tolerant species, including yellow-poplar, the oaks, and black cherry were larger in diameter on the sample sites than reported in the 2000 statewide inventory. By contrast, the average diameters of red and sugar maple were similar to the statewide averages. American beech was the only shade-tolerant species whose diameter was greater on the sample sites than in the state inventory.

To compare the relative quality of timber measured on the sample sites to that of timber throughout West Virginia, we compared the proportional BA of sawtimber size trees for tree grades 1 and 2. Although the proportion of all trees of these grades was higher on the sample sites than for the state, yellow-poplar was the only species that had a statistically significant higher proportion. The quality of chestnut oak measured on the sites was significantly lower than the average for West Virginia.

The shade-tolerant species generally had the lowest proportion of BA in tree grades 1 and 2. For red and sugar maple, part of this reduced grade is associated with smaller diameter trees. However, American beech had the lowest percentage of grades 1 and 2 trees compared to other species tallied on the sample sites.

---

[2] Because the average estimates of BA were developed from estimates of number of trees of various diameters, it is impossible to develop an accurate variance estimate for BA. Thus, we treat this estimate as a constant in our analysis.

Harvesting and Basal Area Removed

The harvesting criteria used, BA removed, and average number of markets for the 28 sites examined are presented in Table 2. Diameter-limit cutting (DLC) was the most commonly observed harvesting method. However, the data indicated several instances in which large-diameter beech were left uncut even though they exceeded the target diameter-limit and several instances in which black cherry and sugar maple were cut even though they did not meet the target diameter-limit. The use of DLC is motivated by operational efficiency and profitability goals of sawmills and logging operations. Hardwood lumber grades are based on long, wide, clear board sections (Smith 1967), that usually result from large-diameter timber. Larger diameter logs also require less sawing time per board foot of lumber produced (Rast 1974). Loggers are paid for volume of timber produced and can make more money by cutting larger trees. These economic realities will continue to dictate residual-stand attributes so long as there is no incentive to change.

Loggers at six sites did not specify logging criteria but a combination DLC and cutting for value apparently was used. The five stands that were cut with a stated management criteria had lower BA removed, but we could not determine whether this lower removal rate was significant because of the limited number of observations. We expected that an increase in the number of markets would increase the frequency of managed cuts or clearcut, but no such trend was discerned.

In Table 3 the number of sites on which specific focus species were found is listed and the average percentage of BA harvested of focus species is compared to the average BA of all trees removed from those sites. The oaks and other mid-tolerant or shade-intolerant species generally were harvested at greater levels, but only yellow-poplar and black cherry had significantly higher removal rates (Table 3). Because shade-intolerant and mid-tolerant species tend to be larger in diameter, a greater volume of these species usually would be removed by DLC. The relatively high BA of yellow-polar harvested appears to be the result of multiple markets for this species. This high rate of cherry harvest is consistent with the higher value, quality, and yield of that species.

By contrast, the maples, American beech, and hickory were harvested at significantly lower levels. Both DLV and the small average diameter of the maple species on nearly all sites examined contributed to the low BA harvested. The average diameter of the American beech tallied on the survey sites was fairly large, but the proportional BA of beech removed was small.

Hickory species were the least harvested with less than 3% of the BA removed on 13 sites containing these hickories. The diameter of the hickory species was only slightly greater than that of the maples. The relatively high volume of small-diameter hickory on the measured sites was one factor that influenced the low volume of these species harvested (Table 3). Also, hickory is difficult to process due to its high specific gravity. Mills that process this species are mid-size and small circle mills that may not have been adequately accounted for in the survey due to our focus on larger operations.

Table 3-- Number of sites where focus species were found, average basal (BA) area cut of focus species versus all species on sites containing focus species, and average diameter of focus species versus all trees on sites containing focus species.

Focus species	Number of sites where focus species were found[1]	Average BS cut of: Focus species	Average BS cut of: Sites containing focus species	Average DBH of trees of: Focus species	Average DBH of trees of: Sites containing focus species
	Number	-------percent--------		-------inches---------	
Yellow-poplar	19	57.4[3]	44.7	14.5[4]	11.3
Chestnut oak	7	55.4	47.4	13.8[3]	11.8
Red maple	16	27.8[4]	51.8	8.9[4]	11.3
White oak	13	46.9	41.3	14.3[4]	11.1
Nor. red oak	16	58.8	44.9	15.2[4]	11.2
Sugar maple	19	27.3[4]	46.9	9.3[4]	11.3
Hickory	13	2.9[4]	46.2	9.8[3]	11.0
Beech	10	20.6[3]	45.9	13.3	11.6
Black oak	9	63.8	43.5	17.2[4]	11.2
Black cherry	4	84.8[2]	54.1	13.0	12.1

[1] On sites where focus species accounted for at least 5% of total basal area.
[2] Significantly different from site average at 0.1 probability level for a t-test: paired two sample for means.
[3] Significantly different from site average at 0.05 probability level for a t-test: paired two sample for means.
[4] Significantly different from site average at 0.01 probability level for a t-test: paired two sample for means.

Conclusion

Our objective was to determine how multiple markets influence the selection of harvest sites and the characteristics of trees removed from these sites. The results of our study were mixed. Although the addition of multiple markets for yellow-poplar roundwood seems to have influenced site selection and the removal of this species, the continued dominance of DLC and/or a combination of DLC and value cutting seem to dominate the type of timber harvested. This resulting pattern of partial harvests will continue to favor the regeneration of shade-tolerant species such as red and sugar maple.

Literature Cited

Burns, R.M. and B.H. Honkala. 1990. Silvics of North America, Vol. 2, Hardwoods. Washington DC: USDA Forest Service Agriculture Handbook 654. http://na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm

Carvell, K.L. 1986. Effect of past history on present stand composition and condition. In: Smith, H.C. and M.C. Eyer, eds. Guidelines for managing immature Appalachian hardwood stands: workshop proceedings. May 28-30, Morgantown WV. SAF Publ. 86-02. West Virginia University Books, Morgantown, WV. p. 1-7

Hanks, L.F., G.L. Gammon, R.L. Brisbin, and E.D. Rast. 1980. Hardwood log grades and lumber grade yields for factory lumber logs. For. Ser. Res. Pap. NE-468. USDA For. Serv., Northeast For. Exp. Stn. Broomall, PA 92 p.

Hardwood Market Report. 1990 to 2001. H. Jones (ed). Memphis, TN.

Rast, E. D. 1974. Log and tree sawing times for hardwood mills. For. Serv. Res. Pap. NE-304. Northeastern For. Exp. Stn. Upper Darby, PA: 10 p.

Schuler, A, and C. Adair. 2003. Demographics , the housing market, and demand for building materials**.** Forest Prod. J. 53(5):9-17.

Schuler, A, C. Adair, and E. Elias. 2001. Engineered lumber products, taking their place in the global market. Journal of For. 99(12): 28-35.

Smith, W.R. 1967. Simplified guidelines to hardwood lumber grading. USDA Forest Serv., Southeastern For Exp. Stn. Asheville, NC. 26 p.

USDA Forest Service. 2004. Forest inventory mapmaker Version 1.0 USDA Forest Service, North Central Res. Stn., St. Paul, MN. http://ncrs2.fs.fed.us/4801/fiadb/index.htm

West Virginia Bur. of Comm. 1997. The forest industry of West Virginia. Division of Forestry, WV Bur of Comm. Charleston, WV. 75 p.

Concurrent Session 1B: Certification

Forest Certification:
Are Mutually Recognized Standards Feasible?

Carolyn Fischer, Resources for the Future, Francisco X. Aguilar[1], School of Renewable Natural Resources, Louisiana State University and Roger A. Sedjo, Resources for the Future

Abstract

Forest Certification Programs have emerged as a result of the active roles that industry associations, environmental nongovernmental organizations (NGOs), national governments, and international organizations have played in developing and promoting codes of conduct that formally sanction and certify sustainable forest management. We describe the emergence of forest certification standards, outline current certification schemes and also discuss the limited success of certification and some of the obstacles to its adoption in developing countries. The current diversity of forest certification programs and ecolabeling schemes has created a costly, less-than-transparent system that has been largely ineffective in terms of the initial goals of reducing tropical deforestation and illegal logging. Some steps have been taken toward harmonization of different certification criteria as well as endorsement and mutual recognition among existing forest certification programs. A common international certification standard could help avoid discrimination against any particular program or region of the world.

Key Words: Forest certification, codes of conduct, chain of custody, Forest Stewardship Council, PEFC, Sustainable Forestry Initiative, sustainable forest management

[1] Presenter. Graduate Research Assistant. 227 RNR Bldg. LSU. Baton Rouge, LA 70803. faguil1@lsu.edu. (225) 578-4133(v); (225) 578-4251 (fax).

Introduction

The forestry industry provides a good illustration of the active roles that industry associations, environmental nongovernmental organizations (NGOs), national governments, and international organizations can play in developing and promoting codes of conduct that formally endorse sustainable forest management. The development of these certification programs reflects some of the challenges to worldwide dissemination of common codes of conduct, particularly in developing countries.

Media and environmental NGOs raised public concerns regarding illegal logging of tropical hardwoods and clear-cutting practices in North America during the 1980's. As a result of public and market pressures forest certification and ecolabels for wood products emerged as a response to potential boycott campaigns against major retailers. Several national and international certification standards developed to address the operation of the forestry industry, promising benefits to all stakeholders from forest owners to consumers in the 1990s. Certification would provide consumers with desired information about the environmental impacts associated with the forest products they purchase. For corporations, forest managers, and landowners, certification and ecolabels would be tools for gaining market access or competitive advantage by demonstrating responsible forest management. For governments, certification and ecolabels offer soft policy instruments to promote environmentally sound practices through demand-side responses (Stevens *et al*. 1998, Eba'a Atyi and Simula 2002).

Although certification has gained popularity in recent years, price premiums have been elusive for forest owners and manufacturers. Also, contrary to the original target of conserving forests in developing countries, these programs have overwhelmingly certified sustainable management practices in developed countries.

Major Forest Certification Programs

The World Trade Organization places forest certification standards in the category of process and production methods standards, which in this case specify how natural resources are managed and how harvesting is carried out. The wood products industry has adopted different certification schemes for sustainable forest management and chain-of-custody regulatory measures. Chain-of-custody refers to the ability to track products from the forest to the final consumer. The process documents all phases of ownership, processing, and transportation. Products traced by a chain of custody are identified by an ecolabel (Anderson and Hansen 2004b).

Forest management and chain-of-custody certification attempt to address the operation of the entire industry, rather than building niche markets for specialty products. Figure 1 illustrates the formation, adoption and application of forest certification schemes. Every program is governed by a Board often comprised of representatives from the industry, academia, NGOs, communities and other stakeholders. This group of stakeholders is responsible for the development and approval of criteria for a certification program. These certification criteria should be applied by forest owners, and the primary and secondary wood products manufacturers that seek certification.

Forest management units, transportation operations and manufacturing facilities are audited and certified by a third-party organization independent from the organization issuing certification criteria.

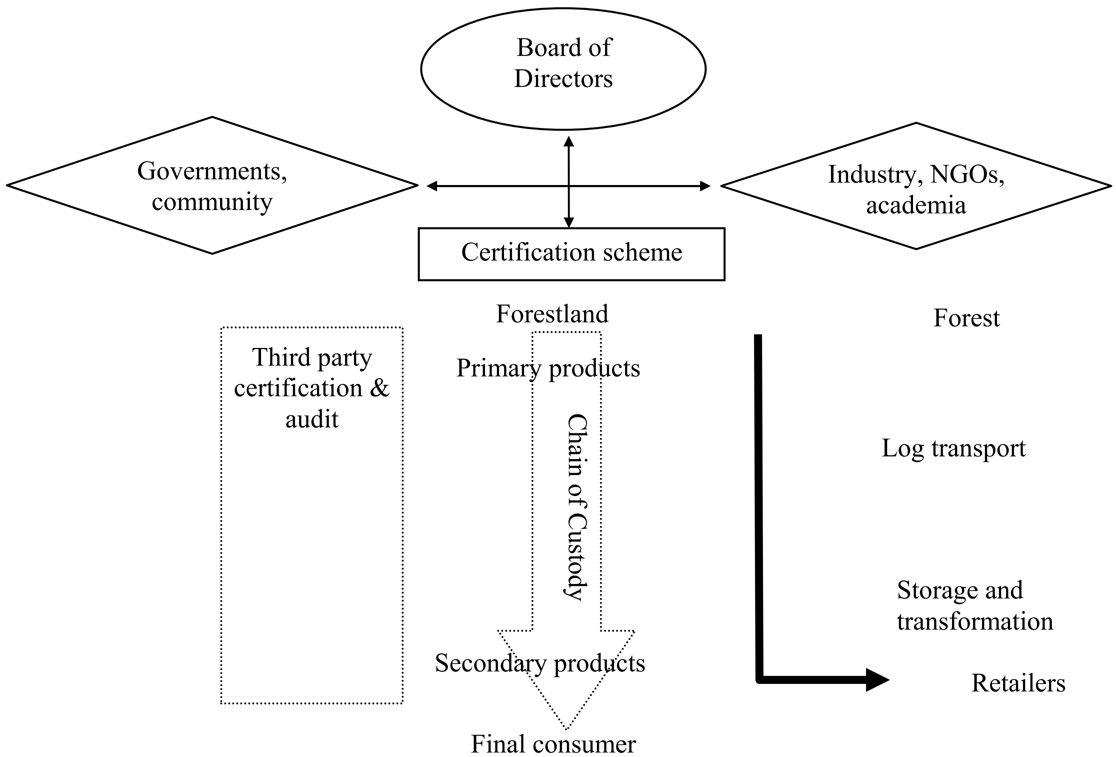


Figure 1. Illustration of Forest Management Certification, Chain of Custody and role of independent auditors in the market for certified forest products.
Source: Aguilar and Duery 2005.

Globally, the three most widely adopted certification schemes are the Forest Stewardship Council (FSC), PEFC (originally Pan European Forest Certification, now Program for the Endorsement of Forest Certification), and Sustainable Forestry Initiative (SFI) (Eba'a Atyi and Simula 2002). In North America, the main forest certification programs are FSC, SFI, American Tree Farm and Canadian Standard Association Sustainable Forest Management Program (CAN/CSA Z809). For a detail discussion and comparison of different certification programs please see Vlosky *et al* (2005) and Fischer *et al* (2005).

Table 1 shows the major certification programs and lists countries with large areas of certified forestland. Notice that the majority of certified forests are located in North America and Europe.

Given the geographic distribution and size of certified forests it suggests that certification has been rapidly adopted in vast areas of temperate forests responding to a public concern on the sustainable forest management in these areas. However, we argue that a large number of different schemes is costly and may cause confusion among consumers. Regarding cutback of

Table 1. Certified forest areas classified by selected countries and certification standard (million of hectares)

	Forest Certification Standard					
Country	SFI	FSC	CSA	PEFC	Tree Farm	Total
Canada	33.9	4.9	63.7			101.5
USA	18.7	6.7			10.5	35.9
Finland		<0.01		22.3		22.3
Sweden		10.4		6.4		16.8
Norway		0.01		9.2		9.2
Germany		0.5		6.9		6.9
China		4.4				4.4
Austria		<0.01		3.9		3.9
Russia		3.9				3.9
France		0.01		3.6		3.6
Poland		3.2				3.2
Brazil		2.9				2.9

*Bolivia, Croatia, Czech Republic, Chile, Latvia, South Africa, United Kingdom, Estonia, Lithuania all have more than one million hectares of certified forests.

Sources: Canadian Sustainable Forestry Certification Coalition (n.d.), FSC (2005b), Forest Certification Resource Center (2004), and PEFC (2005).

deforestation in the Tropics, additional costs associated to certification have been a major setback to its widespread adoption in other parts of the world. We will further discuss these issues in the next section.

A by-product of certification programs has been the creation of a new industry of third-party auditing enterprises. Examples include SmartWood for FSC and PricewaterhouseCoopers, Bioforest Technologies, Interforest/Arthur Andersen, and the Plum Line for SFI. Société Générale de Surveillance may be the largest player, offering FSC, SFI, and PEFC certification; 57% of all FSC-certified forests are certified by Société Générale de Surveillance (Eba'a Atyi and Simula 2002).

All forest certification and chain of custody standards are under constant revision in an attempt to incorporate concerns from different stakeholders including social, environmental and industry groups. For example, SFI and FSC are both reviewing the implementation of the FSC Principles and Criteria in plantations. FSC issued new chain of custody and labeling standards in October 2004, which are to be fully adopted by July 2005 (FSC 2005). The continuous update of standards for forest management, chain of custody and labeling can be costly and cumbersome to participants of the program while confusing to consumers.

Toward a Common Standard: Issues for Harmonization

The Confederation of European Paper Industries has identified 21 national and international certification schemes worldwide (Rupert 2001). The diversity of national, regional, and global schemes can create confusion among consumers and hinder competition among suppliers, who may not be able to afford multiple certifications for multiple clients. Today, the market seems to be moving toward mutual recognition and harmonization of the major international standards, if not a common global certification standard.

The Food and Agriculture Organization of the United Nations, the German Agency for Technical Cooperation, and the International Tropical Timber Organization called for a seminar in 2002 to compare international schemes and develop common definitions and indicators. These organizations have served as facilitators in the process of adopting common guidelines for national and international standards. In considering a convergence to a common international forest standard, it is valid to ask whether harmonization or diversity is better for overall welfare. There may be trade-offs between the benefits of differentiation and the costs of overlapping verification requirements. Several complications related to forest products pose challenges for the development of common standards. In an effort to expedite program harmonization, the International Forest Industry Roundtable suggested the adoption of a set of different criteria to support the adoption of an international mutual recognition framework for forest certification schemes. Table 2 presents the themes and criteria that should be included in the proposed framework (Griffiths 2001).

Table 2 : Components of an international mutual recognition framework as suggested by the International Forest Industry Roundtable

Theme	Criteria
Conformity with Sustainable Forest Management (SFM) standards and legislation	The certification system shall require conformance with a nationally (or regionally/sub nationally) accepted standard for sustainable forest management which is consistent with internationally agreed sets of SFM Criteria and Indicators and which complies with applicable legislation, including ratified international agreements (e.g. Convention on Biodiversity).
Participation	The certification system shall be open and accessible to all interested stakeholders. The influence of all stakeholders shall be balanced and consensus outcomes shall be sought.
Scientifically supported	The SFM standard shall be scientifically supported. Views shall be supported by knowledge or the weight of current scientific opinion.
Continual improvement	The certification system shall be responsive to new knowledge, amenable to changed public values, and shall contribute to continual improvement in sustainable forest management.
Non discriminatory	The certification system shall be non-discriminatory, among all forest types, sizes and ownership structures.
Repeatability, reliability and consistency	The certification system shall ensure the results of independent audits are repeatable and consistent.
Independence and competence	Audits and certifications shall be carried out by competent, independent third party certification bodies and auditors, who are accredited through internationally accepted procedures. All certification institutions (including those involved in forest assessment, accreditation, standards setting, and dispute resolution) shall be free from conflicts of interest.
Transparency	The certification system shall be transparent. All interests can identify and comprehend standards and institutional frameworks. Procedures and documentation shall be clear, concise and readily available
SFM Claims	Certification procedures shall include guidelines designed to ensure all SFM claims are clear, unambiguous, substantiated, and consistent with relevant national and international laws, standards and guidelines.

Source: Griffiths (2001).

Next, we briefly discuss some major issues that are barriers to the development and adoption of common international forest certification standards.

Certification Criteria

A degree of harmonization might be achieved among international, national, and private forest certification programs if a set of minimum requirements for sustainable forest management were developed (Whiteman *et al* 1999, Eba'a Atyi and Simula 2002). A common standard would have to choose common criteria and commit to system- or performance-based standards. By compressing standards, the strongest and weakest programs are naturally eliminated, even though each might have its place given different consumer preferences and compliance costs. To comply with a system-based certification scheme, a company must demonstrate that it has a management system in place to identify, measure, and monitor its impact on the environment and to improve environmental performance. However, the company is not required to meet any particular standard. Rather, collection of the monitoring information itself is seen as a desirable first step toward improving performance. A performance-based scheme goes further and requires the company to meet certain standards or report achievement in a quantitative way (Costa and Ibanez 2000). Experience in the timber and forest products industry seems to indicate that a performance-based scheme is better suited for manufacturing but a system-based approach is more appropriate to the certification of forest management practices. Nevertheless, a combination of both is probably necessary.

Outsourcing and Commingling

Commingling of certified and non-certified wood is a major challenge toward the development of common certification standards. Because of increased globalization and outsourcing in the forest products industry, particularly manufacturing, end products often mix wood and fiber inputs from certified and uncertified sources. Given manufacturers' large product volumes and many lumber suppliers, it is difficult to track wood products from manufacturers back to their original sources. Hence, standards for procurement allow these products to enter the certified stream. To address labeling concerns, the PEFC and SFI have set a minimum content of certified wood or fiber that solid wood products, chip and fiber products, and assembled products must contain. FSC has recently issued a new set of labels for products containing 100%certified, products with mixed sources and Recycled products (FSC Chain of Custody 2005). PEFC minimum content is 70%, and SFI minimum requirement is 66% (Forest Certification Resource Center n.d.).

Ecolabeling and Consumer Credibility

The diversity of ecolabels (which reflect the multitude of certification schemes and types of products) can be confusing to consumers and weaken the credibility of all labels. Consumers prefer detailed information that labels often do not provide. In addition, current label formats make it difficult to compare product attributes because they do not differentiate between plantations and natural forests or among the environmental services provided by the forests. Information about the endorsing entities and the evaluation procedure could help bolster consumer confidence and influence consumers' selection of ecolabeled products (Rickenbach 2002, Teisl *et al*. 2002, Anderson and Hansen 2004a, 2004b). On the one hand, a certain level of coherency among current standards could help avoid confusion among consumers. On the other hand, consumers in different markets may hold diverse views about which environmental information is important when they make purchasing decisions. In that case, standardization could inhibit differentiation among attributes and the detailed information that consumers desire.

Ozanne and Vlosky (2003) indicate that consumer understanding of the concept of forest certification has increased from 1995 to 2000 but it was still low. According to a recent study by Vlosky *et al*. (Forthcoming), 68% of homeowner respondents indicated they have never seen an ecolabel on wood products.

Certification Costs

The primary benefit to forestry companies of a common standard would be relief from overlapping compliance and certification costs. A single certification could then foster more competition, as suppliers would be free to sell to any client demanding certified products, not only the subset requiring a particular label out of many. It also could foster competition among certifying organizations, further reducing costs. However, if the common standard ends up being more rigorous than the label a forest manager would otherwise have chosen, then compliance costs could rise, meaning some forests might forgo certification.

Final remarks

Concern over rapid deforestation in developing countries initially drew attention to forestry practices. Different stakeholders began to pressure major retailers and lenders to source their products from sustainably managed forests. These companies in turn demand verifiable assurances from their suppliers, due as much to a desire to protect corporate images and avoid blacklisting as to market eco-products to consumers. Several national and international forest certification schemes have been developed over the past 15 years. In that time, forest certification has been widely adopted in developed countries; however, contrary to earlier goals, it has been slow to gain acceptance in developing countries.

Demand for certified products in those countries is low, and costs related to certification and auditing may be prohibitive. In developed countries, despite greater market penetration of certification, there is little evidence that producers of forest products have been rewarded with higher prices. Rather, major retailers and corporate purchasers have made certification a cost of doing business. In retrospect, these results should not be surprising. By succeeding in certifying the mass market of forest products, the industry has surpassed the creation of a niche market, in which exclusivity breeds premium prices by targeting the most environmentally conscious consumers. Thus, in the developed world, the systems have arguably achieved improved environmental management without additional government regulation at little or no apparent cost to consumers while producers have taken on the additional costs to secure markets for their products.

However, the impact of international certification programs is more ambiguous for developing-country producers, who are less able to pay for the costs of certification, face little demand at home for certified products, and see little in the way of premium prices even in export markets. The fact that some major corporate purchasers require certification may even imply fewer markets for developing-country wood and wood products. Reduced demand for exports may relieve some pressure for logging but does not improve producer practices or living standards.

Hence, the question arises as to what extent common, clearer standards could improve incentives for producers, particularly in developing countries, and what other policies might be needed. The sheer variety of certification programs has resulted in segmented markets, difficulties in maintaining credible chains of conduct, and considerable confusion to consumers. On these points, then, the harmonization of forest standards can offer benefits to both suppliers and consumers. However, any harmonization requires some participants to make their standards more stringent and others to water theirs down. Although the easiest basis for developing a framework for a common forest certification scheme probably would be management systems, performance standards would likely have to be incorporated as well.

Because major retailers favor the procurement of wood products certified under a single umbrella-certification program, mutual recognition can broaden markets for finding suppliers and prevent discrimination against any certification program—or region. However, mutual recognition does not necessarily assure retailers and consumers that all participant forest managers meet equivalent standards. Rather, as SFI seeks endorsement by PEFC, those consumers will be assured that all participants meet criteria for management systems. FSC still requires more stringent performance measures. The opportunity for competition among certifiers risks leading to a "race to the bottom," because certifying to the easiest system allows access to all with mutual recognition. However, the programs as a whole have an incentive to maintain credibility, so as long as the minimum standards are appropriate and recognized by all stakeholders, competition may instead primarily help reduce certification costs to landowners.

Because cost is a major barrier in developing countries, this effect could contribute to expanding the area currently certified. However, it is unlikely to be enough. To make forest certification more attractive in developing countries, lower costs are needed; group certification and financial support from governments and international sources are possible means of reducing landowner burdens. On the whole, it is by no means clear whether greater standardization will offer significant help developing-country producers and forests. The benefits of common standards—improved consumer credibility and prices, or lower costs—must be passed on to them.

Unfortunately, it is likely that developed-country stakeholders will reap most of the benefits, as they do now. In the meantime, partial standardization may be more disadvantageous. Notably, the program that is most prevalent in developing countries is more reticent to allow mutual recognition, whereas the systems well seated in developed countries are moving toward consolidation. This trend may exacerbate issues of market access.

Even with a successful certification program for exported wood, significant environmental improvements are hardly guaranteed. Most wood is consumed locally, and the pressures for certification do not apply there as they do in developed countries. For illegal and open-access harvesting to become less worthwhile, domestic timber prices would have to fall.[2] Yet if higher

[2] The value of cleared land also plays an important role, since deforestation often occurs to convert land to agriculture.

export prices have any effect, it would be to put upward pressure on domestic prices, by diverting supply toward certification and export, or by the laundering or smuggling of wood products into the export market. Since locally processed wood products (like plywood or furniture) represent an important link between uncertified wood and export markets, national certification programs in developing countries must work harder to incorporate and enforce standards for those products, not just harvesting practices. Even then, processors in third countries still provide ready links between uncertified timber and wood products exported to developed countries.

Ultimately, however, the biggest challenges for forest management in developing countries lie beyond the scope of mass certification: poverty and insecure land tenure. Certification can make a difference in some areas, such as those offering particular products slated for export. But because the vast majority of wood is harvested for local consumers, they cannot afford to pay extra for an ecolabel, and because producers are not sufficiently secure to take a long-term land management view, large-scale impacts still seem remote.

Literature Citations

Aguilar, F.X. and S. Duery. 2005. Certification: A market competitive advantage for the U.S. forest products industry. Certification: Technical Forum Presentation. Manufacturing Competitiveness of the Forest Products Industry. November 3-5, 2004.

Anderson, R.C., and E.N. Hansen. 2004a. The Impact of Environmental Certification on Preferences for Wood Furniture: A Conjoint Analysis Approach. Forest Products Journal 54(3): 42–50.

———. 2004b. Determining Consumer Preferences for Ecolabeled Forest Products: An Experimental Approach. Journal of Forestry 102(4): 28–32.

Costa, S., and L. Ibanez. 2000. Forest Certification: Performance-Based Approach Versus Process-Based Approach. Paris, France: Institut National de la Recherche Agronomique. October. 14 p.

Eba'a Atyi R., and M. Simula. 2002. Forest Certification: Pending Challenges for Tropical Timber. International Tropical Timber Organization (ITTO) Technical Series No. 19. Yokohama, Japan: ITTO. October. 66 p.

Fischer,C., F.X. Aguilar, P. Jawahar and R. Sedjo. 2005. Forest Certification: Toward Common Standards. Discussion paper, Resources for the Future.. Washington D.C.. 28 p.

Forest Certification Resource Center. 2004. Certified Products. Available at http://www.certifiedwood.org/search-modules/SearchProducts.aspx. Accessed 08/07/04.

Forest Stewardship Council. 2005. Chain of Custody. http://www.fsc.org/coc/. Accessed 06/15/05.

Griffiths, J (ed.), 2001, Proposing an International Mutual Recognition Framework. International Forest Industry Roundtable. http://research.yale.edu/gisf/assets/pdf/tfd/IFIR_report.pdf. Accessed 05/20/05.

Rickenbach, M.G. 2002. Forest Certification of Small Ownerships: Some Practical Challenges. J. For .100(9): 43–46.

Rupert, O. 2001. Comparative Matrix of Forest Certification Schemes. Brussels, Belgium: Confederation of European Paper Industries.
http://www.forestandtradeasia.org/files/CEPI_matrix.pdf Accessed 08/15/05.

Stevens, J., M. Ahmad, and S. Ruddell. 1998. Forest Products Certification: A Survey of Manufacturers. Forest Products Journal. 48(6): 43–49.

Teisl, M.F., S. Peavey, F. Newman, J. Buono and M. Hermann. 2002. Consumer Reactions to Environmental Labels for Forest Products: A Preliminary Look. Forest Products Journal 52(1): 44–50.

Vlosky, R. P., Aguilar, F.X. and Duery, S. Future Status and Potential Future Developments for Forest Certification. P. 66-79 in Proceedings of the Louisiana Natural Resources Symposium. Todd Shupe/Michael Dunn (eds.). Louisiana State University Agricultural Center.Baton Rouge, Louisiana..

Vlosky, R.P., S. Duery, T. Black, and A.A. Chajtur. The Demand Perspective on Certified Tropical Hardwood Product Markets in the United States. Louisiana Forest Products Development Center, LSU AgCenter. Baton Rouge, Louisiana. In Progress.

Whiteman, A., C. Brown, and G. Bull. 1999. Forest Product Market Developments: The Outlook for Forest Product Markets to 2010 and the Implications for Improving Management of the Global Forest Estate. Working Paper prepared for the World Bank Group Forest Policy Implementation Review and Strategy. Rome, Italy: Forestry Policy and Planning Division. July.

Compensation claims in voluntary forest conservation: A case of private owned forests in Finland

Erkki Mäntymaa, University of Oulu[1], Artti Juutinen, University of Oulu, Sari Matinaho, University of Oulu, Mikko Mönkkönen, University of Jyväskylä and Rauli Svento, University of Oulu

[1] Assistant Professor, Department of Economics, University of Oulu, P.O.Box 4600, FIN-90014 University of Oulu, Finland. Erkki.Mantymaa@oulu.fi. +358-8-5532944 (v); +358-8-5532906 (fax).

Compensation claims in voluntary forest conservation: A case of private owned forests in Finland

Abstract

A new marked-based voluntary program to preserve forest habitats on private land has been implemented for testing in Finland. It bases on nature conservation by fixed-term contracts between landowners and an authority that represents national government under a given budget constraint. This paper examines the cost-efficiency of the Experiment of Trading in Natural Values in forest conservation analyzing whether landowners' environmental preferences reduce their compensation claims. We describe theoretically how the compensation claims of landowners having different preferences for biodiversity maintenance are determined in the context of forest conservation where the participation into a voluntary conservation program improves environmental quality but causes profit loss in terms of timber production. The preliminary empirical analysis shows some weak indications about the effects of owners' preferences on the compensation claims in the market of natural values. Thus, a voluntary approach including a competitive bidding process may provide cost savings compared with a mandatory conservation program, where compensations are based on the market value of forests. In order to make stronger conclusions we have completed a survey among the owners who have participated in the experiment using a questionnaire with a set of detailed questions on their attitudes, preferences and other background variables.

Keywords: biodiversity protection, voluntary agreements, environmental preferences

1. Introduction

There has been a growing interest to use of voluntary agreements (VAs) as an environmental policy tool. Typically, they are praised for being politically feasible and more efficient than traditional mandatory approaches. Voluntary approaches have historically been used in several fields, but most notably, perhaps, they have been used in agriculture to reduce pollution in soil conservation and other erosion control programs such as the U.S. Conservation Reserve Program (see, e.g., Segerson and Miceli 1998). In Austria, VAs are used to protect forests for biodiversity maintenance (Frank and Müller 2003). A similar approach is experimented currently in Finland.

A new marked-based voluntary program, hereafter termed the Experiment of Trading in Natural Values (ETNV), to preserve forest habitats on private land has been implemented for testing in Finland. In this country non-industrial private forest owners possess over 14 million hectares of forests being about 53 % of the total forestry land. These forests are primarily used for timber production which is the most important reason for endangering of species in Fennoscandia (Esseen et al. 1997, Rassi et al. 2001). Most of the non-industrial private forests are located in southern Finland, where protected areas (PAs) cover less than 1 % of the forested land. Thus there is an urgent need to extend the conservation network in this part of the country (Hanski 2000). It is likely that a mandatory approach, such as land taking, would bump into an intense resistance expressed by displeased landowners. Therefore, a voluntary program seems quite attractive policy tool for conserving biodiversity maintenance in these circumstances.

This new practice bases on the concept of nature conservation by fixed-term contracts agreed between landowners and the authority that represents Finnish government under a given budget constraint. According to these contracts the forest owners produce biodiversity services in their lands and receive a compensation/incentive payment. The aim of ETNV is to create markets for biodiversity services in a manner that has a broad acceptance in society and in particularly among forest owners. Thus, not only being politically feasible ETNV may also be cost-effective.

Economic efficiency entails maximizing the difference between the conservation benefits of PAs and the costs of preserving them. The costs include not only the opportunity costs of protecting individual properties, but also the information and transaction costs paid by landowners and government. Many previous studies have brought out the potential advances of using voluntary-based instruments in nature conservation instead of regulatory approaches (e.g. Innes et al. 1998, Michael 2003). The main arguments are that transaction and opportunity costs can be lower under the voluntary approach. Transaction costs may be lower because of reduced reliance on formal legal procedures and reduced conflict. Lower opportunity costs may occur because VAs are generally thought to provide more flexibility in determining the means by which a target level of conservation would be met (Segerson and Miceli 1998). They also may improve the efficiency of conservation by reducing perverse incentives, which can occur under mandatory approach (Langpap and Wu 2004). In particular, the opportunity costs may be lower, if the conservation-minded landowners can be revealed in the voluntary regime (Smith and Shogren 2002, Michael 2003).

Several studies have analyzed the effectiveness of using VAs (Stranlund 1995, Polasky and Doremus 1998, Segerson and Miceli 1998, Wu and Babcock 1999, Innes 2000, Smith and

Shogren 2002, Langpap and Wu 2004). In general, they have found that the efficiency of VAs may depend on several factors, such as the background threat of regulation, the contract scheme, the supporting public services, the deadweight losses of government expenditures, the number of participants in the program, the cost advantage offered by VAs, and the allocation of bargaining power. However, only a few studies have included empirical analysis (Bizer 1999, Nickerson and Lynch 2001, Michael 2003, Tikka 2003). Thus we are largely lacking empirical evidence for these theoretical findings.

This paper examines the cost-efficiency of ETNV in forest conservation. In particular, we analyze whether landowners' environmental preferences reduce their compensation claims. The cost-efficiency of ETNV depends strongly on how effectively the conservation-minded landowners, those who have low compensation demands and own ecologically valuable sites for conservation, can be attracted to and revealed in ETNV. We first describe theoretically how the compensation claims of landowners having different preferences for biodiversity maintenance are determined in the context of forest conservation where the participation into a voluntary conservation program improves environmental quality but causes profit loss in terms of timber production. Being a suitable tool for this case we will use a standard framework of measuring effects of quantity or quality change of a commodity on consumer's welfare (see e.g. Varian 1992, 160-168 and Kolstad 2000, 298-309) but adding to that analysis an another change, an increase in consumer income. Then, we present a preliminary numerical analysis on how the compensation claims were set in ETNV investigating the relationship between the compensation claims and the property attributes. The data set of the study includes a total population of participants of ETNV. The population is not big as the regulator has a limited annual budget constraint and so far the experiment has continued only two years. Finally, we give some short conclusions of the paper and present avenues for future work.

2. Analytical framework

2.1 General market description

This section analyzes how the forest owner's compensation claim is determined in the voluntary program where the owner and the regulator make a contract that the owner produces biodiversity services in his or her land and receives a compensation payment from the regulator. However, to present the overview of the problem at hand we start the discussion by considering the factors that effect demand and supply of biodiversity services in the context of contractual mechanism.

Hereafter we name the conservation targets as forest stands. For simplicity, we assume that the stands are either strictly protected (temporarily or permanently) or used for timber production. This is a typical situation considering, for example, old-growth boreal forests. Each stand has different ecological characteristics and timber production possibilities. We assume that the aim of the regulator is to maximize net social benefits of conservation. Also, we assume that the regulator can pay different payments for each landowner. The aim of a forest owner is to maximize the net benefits from his or her land. These benefits include both commercial and subjective values as forests provide many products and services. Many of these products and services, such as biodiversity, do not have market price.

The most important factor affecting the demand and supply in this market is the ecological characteristics of the potential conservation target. First, the stand must fulfill the specific ecological criteria before it can be accepted as a target for conservation, because all types of forests do not need protection. Thus, in this sense, there is no free entry into the market. In practice, these criteria can include several general factors, such as the amount and quality of decaying wood found in the stands, the share of deciduous trees, and the presence of threatened or rare species. Second, the regulator is willing to pay more for higher quality stands that lower quality stands, but the interpretation of quality depends, however, on more specific local goals of conservation. Anyway, this indicates that the regulator has to solve a difficult problem: how to precisely define and measure biodiversity (see, e.g., Weitzman 1992 and Pearce and Moran 1994). Regulator's willingness to pay (WTP) for the protection of the particular stand also depends on the other stands that are available for conservation. Obviously, if there are a lot of similar stands available, the regulator's WTP for this type of stand is lower than in the case that there are no close substitutes for the stand. Moreover, regulator's WTP depends on the existing conservation network, because the regulator may prefer the stands that situate near existing PAs to avoid fragmentation of the forest landscape, for instance. To sum, the goal of conservation in biological terms is not fixed in this program, but it is updated as the program proceeds. Consequently, regulator's WTP for a particular type of stand may change during the process.

Also, supply of biodiversity services and the compensation claims of the forests owners depend on several factors. One important factor is the timber production possibility of the particular stand. This affects how big losses the protection of the stand will cause to the forest owner, i.e., the monetary loss for giving away a possibility to harvest his or her own forest stand and sell timber for money. These losses depend also on wood market, which determines timber prices. However, the goals and preferences of a forest owner affect the compensation claim, too. In practice, the forest management decisions are done and the goals for timber production are set at forest holding level (or at household level), not at stand level. Therefore, the timber production possibilities of a given stand can not solely determine the losses incurred from its protection.

In voluntary preservation of private forests, preferences of forest owners are in a crucial role. Preferences may be environmentally friendly so that a forest owner would not need any or a very small compensation for preserving his or her own forest stand. In the opposite extreme case he or she may not value environment at all and would claim a compensation for preservation that covers all losses from timber production.

2.2 Definition of compensating demands

Let us next consider this issue more closely using two types of forest owners which own similar stands (Fig. 1). Suppose that the first one, the owner *a*, has strong environmental preferences signifying that environmental changes have an influential impact on his or her welfare (Fig. 1(a)). In the figure this is shown by steeply downward sloping indifference curves indicating that a change in environmental quality should be compensated by a large change in income y (or private goods) in order to keep the owner on the same utility level. The second one, the owner *b*, has weaker environmental preferences meaning that environmental changes have smaller impact on his or her welfare (Fig. 1(b)). This means, correspondingly, that he or she should get less y to compensate a decrease of environmental quality to keep his or her welfare constant. We can write the same relationship by comparing marginal rate of substitutions (*MRS*) between y and q and between the two owners as follows:

$$MRS_a(q, y) > MRS_b(q, y) \qquad (1)$$

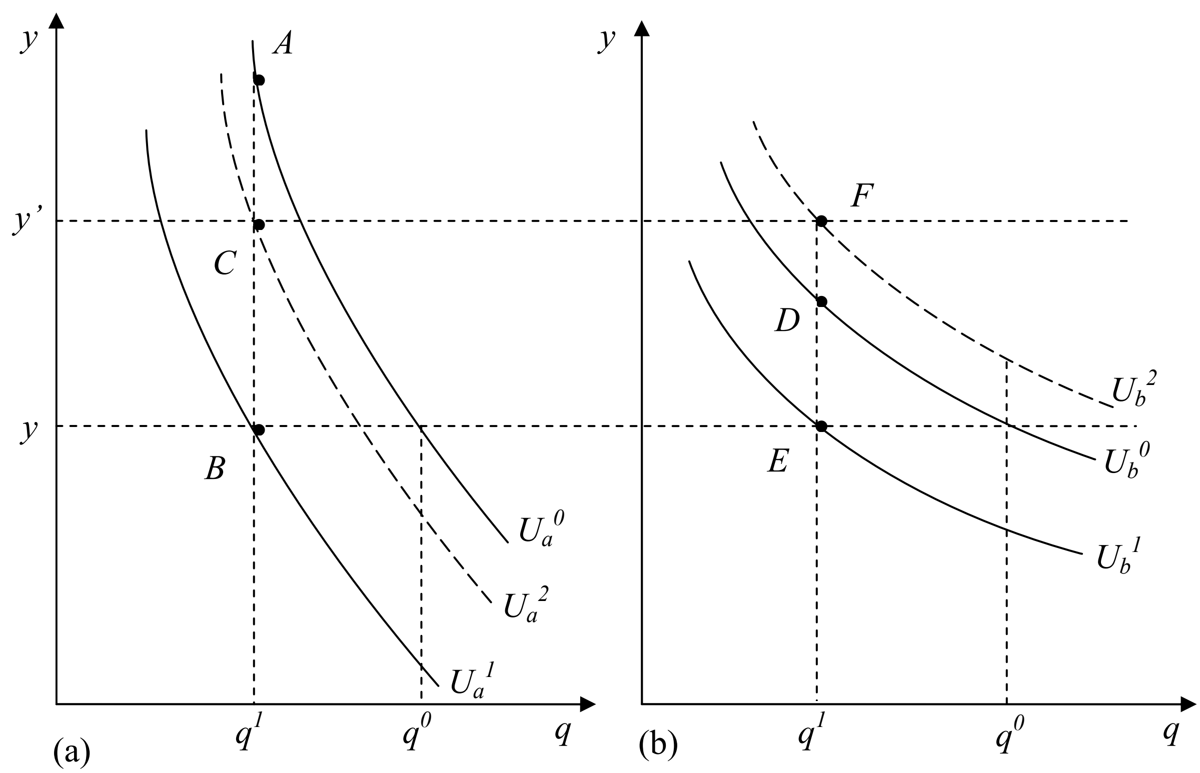


Figure 1. Impact of a change of environmental quality caused by a cutting of an own forest plot to welfare of a forest owner with (a) strong or (b) weak environmental preferences.

Assume that the utility of the forest owners originally is on the level U^0, i.e., the owner *a* is on U_a^0 and the owner *b* on U_b^0 (see Fig. 1(a) and 1(b), respectively). Further, suppose that both forest owners consider to cut a similar plot of their forests which would decrease environmental quality including deterioration of landscape view and recreational benefits in the forests, for example. This would decrease utility of the forest owners from U^0 to U^1.

In order to return to the original level of utility we have to define the value of the compensating surplus. Using an indirect utility function this can be written as

$$v(q^0, y) = v(q^1, y + CS^1) \qquad (2)$$

where *CS* is compensating surplus, a Hicksian measure of a welfare effect caused by a quality or quantity change. In the case of quality decrease compensating surplus CS^1 as defined in Eq. (2) is the income needed to keep the original level of utility at the new environmental quality. In Fig. 1(a) CS^1 equals the line segment *AB* and in Fig. 1(b) to *DE*.

So far we have only considered the quality change of harvesting a stand. The owners would, however, harvest the stands in order to sell timber to forest industry for increasing their harvesting income from y to y'. This would compensate the original utility loss of quality decrease and it is illustrated in Fig. 1 as the movement of utility from U^1 to U^2. If we take the increased income into account in the welfare measurement, we can write

$$v(q^0, y) = v(q^1, y + \Delta y + CS^2) \qquad (3)$$

where $\Delta y = y' - y$ and CS^2 is compensating surplus if the owners decided to harvest and get the income. For the owner a who prefers strongly environmental quality the increased income would not be able to compensate the loss of environmental quality of the cutting (i.e., $AB > BC$) whereas for the owner b the relation would be opposite ($DE < EF$).

A comparison of the total effects of these two changes (i.e., the first one caused by the environmental decrease from U^0 to U^1 and the second one by the income from sales from U^1 to U^2) between the two owners shows that the net change from U^0 to U^2 is negative for the owner a and positive for the owner b, i.e., $U_a^0 - U_a^2 < 0$ and $U_b^0 - U_b^2 > 0$, respectively (see Fig. 1). This means that the increased income from timber sales would not totally compensate the decrease of environmental quality for the owner with strong preferences (a) but would do that more than completely for the owner with weak environmental preferences (b). With respect to voluntary preservation this has an important consequence: it indicates that the former type of the forest owner is willing to set aside a plot of his or her forest without any repayment until $AB = BC$ or $U_a^0 - U_a^2 = 0$ whereas the latter type of the owner should be paid a positive compensation if $DE < EF$ or $U_b^0 - U_b^2 < 0$ in order to make him or her willing to make an agreement.

We can write the same conditions with help of indirect utility functions. For the owner a the condition is

$$v_a(q^0, y) > v_a(q^1, y + \Delta y) \qquad (4a)$$

meaning that he or she is better off on the original situation and will not choose to harvest his or her stand. For the owner b we can write

$$v_b(q^0, y) = v_b(q^1, y + \Delta y - CS_b^2) \qquad (4b)$$

representing that he or she should be paid a negative compensation or taken off the amount of CS_b^2 in order to keep him or her as well off as in the original situation. Inversely, without a positive compensation equal to CS_b^2 the owner b would decide to cut his or her stand, get the income from the timber sales and move to the higher utility level U_b^2.

If a regulator of environmental policy could identify the types of preferences of the forest owners he or she could find the most environmentally friendly owners. Combining this information to a data set on environmentally valuable forest plots the regulator would be able to make an optimal combination of preservation areas and a socially efficient solution of environmental protection.

There is, however, a problem of asymmetric information between a regulator and forest owners in voluntary preservation of private forests because the regulator does not know owners' preferences. Moreover, forest owners do not have an incentive to tell the truth about their preferences to the regulator. Instead of telling them truthfully a forest owner with environmentally friendly attitudes may have an incentive to behave strategically and reveal untrue preferences in order to get money for preservation although he or she would be willing to preserve the stand without any repayment.

Another source of asymmetric information may be goals of owners with respect to timber production which, after all, determines how big timber sales and income are. One owner may maximise his or her income by harvesting as much as it is possible in the long run while another one may postpone harvesting in order to leave the property for next generations, for example. Now the former would need a full compensation for an agreement but the latter might refrain from harvesting in any case and would be satisfied with a minimal repayment. Thus it is difficult for the regulator to find an optimal solution since he or she does not know the motives of the owners.

A solution for the problem of asymmetric information may be found if a competitive bid process could be developed for voluntary preservation including bargaining in which several forest owners offer their forest plots for preservation. In this kind of trade the owners compete for agreements with each other and take into account their own preferences for environmental quality and other motives as well as that a too high compensation claim may not result in agreement. This is a market of VAs where owners with strong environmental preferences or those who are not intending to harvest a valuable stand in a contract period anyway may claim smaller compensations and will conclude an agreement in place of owners with weak environmental preferences or those who wish to maximize timber production.

3. Empirical case

In this section we examine empirically the compensation claims of forest owners by using information from the Experiment of Trading in Natural Values (ETNV), which started at May 2003 in Satakunta region in southern Finland and will continue as an experimental project to the end of the year 2007. However, let us first describe the key features of ETNV.

3.1 Description of the Experiment of Trading in Natural Values

The basic idea of ETNV bases on landowners initiative to protect his or her own forest. The process starts when a landowner offers his or her land into the program by submitting a specific declaration form to the regulator, the regional Forest Centre. The form includes a description of the ecological characteristics of the offered conservation target, which can include several stands. Landowners are also expected to submit an asking price for the beginning of the negotiations. Typically, the protection means abstaining from timber management but it can also cover tasks improving the ecological quality of the stand in the long run. In the experiment the contracts are in force for a limited period lasting 10 years. Compensation payments are paid off at once at the beginning of the contract period and they are exempt from taxes.

In the next phase of ETNV the regulator checks the declaration form and assesses preliminarily wheatear the offered target is feasible to be a potential target for conservation or not. If it seems that the quality of the offered target is high enough, the nature value expert from the Forest Centre makes an inventory in the forest and checks if the forest fills the biological criteria of nature protection. Otherwise the regulator informs the landowner that the offered target is not worth of protection and there will be no agreement.

After the field inventory, if the regulator is still considering the target good enough for conservation, he or she calculates the compensation value of the target by using a certain valuation mechanism, which includes subjective prices for different ecological characteristics. It includes also a capitalized value for the loss of delayed harvesting calculated by using 1% interest rate to forest value and expected decay of wood. Thus the regulator has a good knowledge on the timber production possibilities of the target due the field inventory.

Finally, the regulator and the landowner will negotiate about the compensation payment and the required protection activities. In most cases the protection means that no silvicultural activities are done in the forest but in some cases careful cuttings and treatment can be allowed. It should be noted that there is no explicit background threat for the landowner. He or she is free to withdraw from the process at any time and after ten years the forest owner can freely decide of the use of the forest according to principles of that time. However, it is possible that if the voluntary experiment does not perform well, a mandatory protection program will be implemented later to protect forest in southern Finland similarly than has previously been done in protecting forests in northern Finland. The negotiations can be interpret as a competitive bid process, because several landowners are offering their forests for the program simultaneously and the regulator can pay different payments for each landowners. Moreover, the regulator works under a given budget constraint and therefore it is likely that all potential targets will not be included into the program.

ETNV creates market for biodiversity services, but it has limitations and faces several problems. Because ETNV bases on landowners voluntary participation and their initiates, the best targets for conservation from ecological viewpoint may not be reached in the program. Thus ETNV may not achieve the goals of the conservation. For this reason, perhaps, the Forest Centre has been cautious to set specific ecological goals for ETNV. Also, the Forest Centre may not just maximize social welfare, but may have motive to promote landowners interest, which is the original aim of this organization. Obviously, landowners prefer a voluntary approach to mandatory conservation, and therefore, the Forest Centre may be unwilling to reveal that ETNV is not achieving the ecological goals. This problem may also reflect in the negotiations. The regulator may not be very anxious to use competitive bidding: this would lower the payments for landowners. If there is no competition between owners, they do not have an incentive to reveal their private information and may ask high compensations for protection of their properties.

One particular problem of ETNV came out in the beginning of the program. Most of the landowners did not submit asking prices for the negotiations, and therefore, the regulator showed his or her calculated compensation value as a starting point for negotiations. The regulator wanted to treat landowners equitably as there was only very little information on the value of biodiversity services available for landowners. Naturally, in this practice, the landowners that originally would have a lower compensation claim than the regulator's value had an opportunity not to reveal their preferences but claim a higher compensation than what they were told. For this reason, in what follows, we will divide the contracts into two groups, year 2003 and year 2004 and analyze them separately. Let's now consider the actual compensation claims and payments.

3.2 Numerical results

From the beginning of ETNV in 2003 until the end of 2004 altogether 104 forest owners offered their lands, all in all 119 stands or 679.1 ha of forest, for preserving in the experiment in Satakunta region, Finland. In 2003 agreements were made with 30 owners on 47 stands (253.5 ha) and in 2004 with 35 owners on 43 stands (243.0 ha). The forest owners who submitted their land to ETNV but were not reached an agreement were 29 persons with 29 stands (182.6 ha).

In this analysis we will make calculations using a data set based on 119 stands, i.e., the statistical unit of observation is a forest stand. The data set includes following variables: year when a stand was submitted or agreement made (2003 or 2004), result of negotiations (agreement or non-agreement), surface area of a stand (ha), compensation claimed (€/ha/a), compensation paid (€/ha/a), forest value (€/ha; consisting land value and harvesting value of standing forest), age of forest of a stand (years), and regulator's estimate of ecological value of a stand (points). The data set does not separate the forest owners without an agreement between the years 2003 and 2004. Some of the stands including into ETNV were burned-out, were located in a site with barren soil or does have a poor value of a standing forest for some other reason, all together 35 stands, were excluded from most of the following analyses leaving 84 observation units in the data set.

Although we are interested in owners' compensation claims we will first consider if there is any difference in the structure between the groups of the owners, i.e., the ones with an agreement in 2003 and 2004 and the ones without an agreement. We analyzed four stand attributes with the independent samples t-test for equality of means and found that the mean of forest value (€/ha) and the mean age of the forest stands do not differ from each other between the groups. However, we found a statistically significant differences with respect to the mean surface area of the stands between the groups with an agreement and without an agreement ($p = 0.082$) indicating that the average area of the former group (4.1 ha) is smaller than the one of the latter (6.3 ha). Thus the regulator seems to prefer smaller areas for preservation. This may reflect the budget constraint of the Forest Centre and its aim to make more agreements with the limited funds. Also the mean ecological value of the stands differ statistically between the groups ($p = 0.000$) so that the stands with an agreement have a bigger value (121 points) than the ones without an agreement (81 points) indicating logical behavior of the regulator that ecologically more valuable stands got agreements.

Next we will analyze if the stand attributes have the same type of variation as do the compensation claims. Finding that the Pearson correlation coefficient between the claims and forest value (€/ha) is 0.248 (2-tailed sig. 0.061) we can show only weak dependence between the variables. The reason for this result may be that the owners who submitted valuable forest to ETNV have strong environmental preferences and therefore they were not claiming compensation that covers the losses from delayed harvesting. Another possible explanation may be that the owners are not maximizing timber production at stand level, i.e., they have not an intention to harvest their stands for some other reason and therefore they did not tied their compensation claims in the forest values.

If we calculate correlation between regulator's estimate of ecological value of a stand and the compensation claims we find a clear correlation of 0.545 which is statistically very significant with 2-tailed sig. of 0.000. This result is slightly surprising if we remind the former finding of missing correlation between claims and forest values. It seems that knowing that the regulator is willing to pay more for more ecologically valuable stands the forest owners are ready to behave strategically hiding their possible positive preferences for environment and trying to maximize monetary benefits.

Comparing the means of the compensation claims between the agreements of 2003 (231 €/ha) and 2004 (271 €/ha) we discover that they are not statistically different. If we, however, do the same for actual payments (200 €/ha in 2003 and 172 €/ha in 2004) we find that they are statistically different (independent samples t-test for equality of means, $p = 0.048$) although the ecological value of stands are statistically same. One possible reason for this may be that in 2003 the regional Forest Centre concentrated on for starting up the experiment trying to quickly show the first set of agreements to publicity. This might follow to a less effective competition between owners and "too big" payments during the first year of ETNV. In the second year the feeling of public pressure may have alleviated and the ability of the authority to conduct the experiment may have improved meaning more efficient competition in the new market and more efficient revelation of owners' preferences leading to smaller repayments. A second explanation might arise from targets of environmental policy of the public authority. In 2003 the Forest Centre would have reached some goals with respect to conservation policy and would have taken this into account when making new agreements (i.e., the marginal benefits of conservation are decreasing). This might have followed to lower payments in 2004.

4. Conclusions

In this preliminary analysis we have found some weak indications about the effects of environmental preferences of forest owners on the market of natural values. The fact that we did not find any correlation between the compensation claims and forest values might indicate that the owners who submitted valuable forest to ETNV have strong environmental preferences and were claiming relative small compensation for an agreement. Thus, a voluntary approach including a competitive bid process may provide cost savings compared with a typical mandatory conservation program, where compensations are based on the market value of forests. Previous findings support also this conclusion (Michael 2003). Another result referring to the effect of owners' environmental preferences might be that actual payments of compensation were smaller in 2004 than 2003 might follow to more efficient competition in the new market and more efficient revelation of owners' preference in the second year of ETNV.

Importantly, however, our analysis does not allow us to make any strong conclusions from the compensation claims and the market process of VAs. The correlation coefficients and their statistical tests can give us only weak evidence about the landowners' environmental preferences and their impact on to reduce compensation claims ending up us soon in fruitless speculations without more information of the forest owners. As many other things may explain differences in compensation claims and real repayments, we have conducted a survey among the owners who have participated in ETNV using a questionnaire with a set of detailed questions on their attitudes, preferences and other background variables. Linking property attributes and landowner attributes we will be able to get deeper evidence and make stronger conclusions on compensation claims and actual payments in ETNV.

Literature Cited

Bizer, K. 1999. Voluntary agreements: cost-effective or a smokescreen for failure. Environ. Econ. & Pol. Stud. 2:147-165.

Esseen, P-A, B. Ehnström, L. Ericson, and K. Sjöberg. 1997. Boreal forests. Ecol.Bull. 46:16-47.
Frank, G., and F. Müller. 2003. Voluntary approaches in protection of forests in Austria. Environ. Sci. & Pol. 6: 261-270.

Hanski, I. 2000. Extinction debt and species credit in boreal forests: modeling the consequences of different approaches to biodiversity conservation. Ann. Zool. Fennici 37: 271-280.

Innes, R. 2000. The economics of takings and compensation when land and its public use values are in private hands. Land Econ. 76:195-212.

Innes, R., S. Polasky, J. Tschirhart. 1998. Takings, compensation and endangered species protection on private lands. J. Econ. Perspec. 12:35-52.

Kolstad, C.D. 2000. Environmental economics. Oxford University Press, New York. 400 p.

Langpap, C., and J. Wu. 2004. Voluntary conservation of endangered species: when does no regulatory assurance mean no conservation? J. Environ. Econ. & Manage. 47:435-457.

Michael, J.A. 2003. Efficient habitat protection with diverse landowners and fragmented landscapes. Environ. Sci. & Pol. 6:243-251.

Nickerson, C.J., and L. Lynch. 2001. The effect of farmland preservation programs on farmland prices. Am. J. Agric. Econ. 83:341-351.

Pearce, D., and D. Moran. 1994. The economic value of biodiversity. Earthscan Publications Ltd., London, United Kingdom. 172 p.

Polasky, S., and H. Doremus. 1998. When the truth hurts: endangered species policy on private land with imperfect information. J. Environ. Econ. & Manage. 35:22-47.

Rassi, P., A. Alanen, T. Kanerva, and I. Mannerkoski (eds.). 2001. The 2000 red list of Finnish species (in Finnish). Ministry of the Environment, Helsinki, Finland. 432 p.

Segerson, K., and T. Miceli. 1998. Voluntary environmental agreements: good or bad news for environmental protection? J. Environ. Econ. & Manage. 36:109-130.

Smith. R.B.W., and J.F. Shogren. 2002. Voluntary incentive design for endangered species protection. J. Environ. Econ. & Manage. 43:169-187.

Stranlund, J.K. 1995. Public mechanisms to support compliance to an environmental norm. J. Environ. Econ. & Manage. 28:205-222.

Tikka, P. 2003. Conservation contracts in habitat protection in southern Finland. Environ. Sci. & Pol. 6:271-278.

Varian, H.R. 1992. Microeconomic analysis, 3rd ed. W.W. Norton & Company, New York & London. 548 p.

Weitzman, M. 1992. On diversity. Q. J. Econ. 107:363-406.

Wu, J., and B. Babcock. 1999. The relative efficiency of voluntary vs mandatory environmental regulations. J. Environ. Econ. & Manage. 38:158-175.

Public Forestry Programs and Forest Certification in South America: State and Private Mechanisms for Forest Management and Conservation

Frederick Cubbage and Kathleen McGinley, North Carolina State University[1]

Abstract

State versus private mechanisms for forest management and conservation has been an enduring contemporary theme. This issue is particularly important in developed and developing countries in Latin America, where the percentage of forests certified is small, but increasing; and public forestry agencies are weak, but provide coverage for all forests. The relevance of this issue has increased as forest certification systems have developed in the 2000s in Latin America, providing an extremely visible non-state governance approach for conservation. National laws still provide the foundation to govern forest resource management, utilization, markets, and protection in all countries. The status of and interactions among forest certification, sustainable forest management, and national forestry laws in Latin America are discussed and their prospects for encouraging forest management and protection assessed.

---

[1] Professor and Ph.D. student, respectively, North Carolina State University Department of Forestry and Environmental Resources Raleigh, North Carolina, USA 27695-8008

fred_cubbage@ncsu.edu, kmcginley@fs.fed.us. Tel: (919) 515-7789; Fax: (919) 515-6193.

Introduction

In the last decade, Sustainable Forest Management (SFM) and forest certification have become the dominant paradigms that address forest management and protection in the world. Each of these subjects addresses economic, ecological, and social components of forestry. Several international processes and accords address SFM in temperate and tropical forests. These generally include broad criteria that state principles for forest management, and indicators that can be used to measure and track the status of the world's forests at the national, or perhaps forest management unit, level. Forest certification focuses on measuring forest management, environmental protection, and social benefits from forest ownership and forest practices at the forest management unit or stand level. These new public processes and private forest certification systems all work within the existing context of national, state, or province forestry laws and agencies. The interaction of these public and private policies for forestry and other resources determine the management and protection of forests.

South America has the largest share of its total land area in forests, with about 50% in total. Brazil has the greatest extent of forest in the Americas, covering the fourth largest share at 64% of the land base. Uruguay has the lowest share of forested land in the Americas at 7%. At 29%, Mexico has slightly more of its total land area classed as forested than the U.S. and Canada. In South America, the northeastern countries of French Guiana, Guyana, and Suriname have the highest percentages of their land base under forest cover, ranging from 78% to 90%. The northwestern countries of Bolivia, Columbia, Ecuador, and Venezuela in have a smaller share of their area classified as forests, though still more than North America at 40% to 56% (FAO 2003).

The loss of forest area from 1990 to 2000 was greatest in percentage terms in Central America, at –1.4% per year. South America lost 0.4% per year, and North America lost only 0.05% per year, virtually all in Mexico. In terms of total area, the losses of forests in Brazil and Mexico were the largest, at 2.3 million and 631,000 ha per year. In total, South America lost an average of 3.7 million ha of forests per year from 1990 to 2000.

In North America, planted forests comprise about 11% of U.S. total forest area. While in South America, plantations account for approximately 1% of Brazil's forest area; 3% of Argentina's forest area, 15% of Chile's forest area, 48% of Uruguay's forest area, and only about 1% or less of the other countries in South America. FAO (2003) also reports on forest types and wood volumes by country and region. Canada has 26% temperate and 76% boreal forests; the U.S.A. has 37% subtropical, 48% temperate, and 15% boreal; and Mexico has 70% tropical and 30% subtropical. Most of the countries in South America have 100% of their forest area classed as tropical forest. The only major exception is Chile, with 54% subtropical and 45% temperate forests. Brazil has 2% subtropical forests and Argentina has 5% subtropical and 4% temperate.

FAO (2003) indicates that Brazil has 64% of the timber volume in South America with 71 billion cubic meters, followed distantly by Peru, Venezuela, Bolivia, and Colombia, ranging from 10 billion to 5 billion cubic meters each. The rest of the South American countries each have less than 2.5 billion cubic meters of total timber volume each. In contrast, Canada has 29 billion cubic meters of timber volume, the U.S.A. has 31 billion, and Mexico has 3 billion.

Forest Certification

Forest certification has developed rapidly since 1993, and about 225 million ha, or 6% of the world's forests were certified as of January 2005. Certification's focus on monitoring, auditing, and improving forest practices as well as the economic, ecological, and social benefits at the stand level can make it a powerful tool for effecting change in forest management. Major forest certification systems include the Forest Stewardship Council (FSC, 51 million ha), Programme for Endorsement of Forest Certification (PEFC, 55 million ha), Sustainable Forestry Initiative (SFI, 51 million ha), and the Canadian Standards Association (CSA, 47 million ha).

Forest certification was largely developed as a means to encourage sustainable forestry in the tropics. About 95% of currently certified forest area is in the northern hemisphere, with only about 5% in tropics. There has been an increasing focus on developing and applying forest certification systems in the southern hemisphere. These systems include the Australian Standard, CerFlor in Brazil, CertFor in Chile, and the Malaysian Timber Certification Council.

Until the Brazilian and Chilean certification schemes were initiated in 2002, forest certification in Latin America was dominated by FSC. FSC is the only forest certification system that has been applied throughout the world, and is one of the top three systems in terms of area of forests covered. As of January 2005, the Forest Stewardship Council (FSC) had provided 685 third party audits and certification certificates to 51,320,494 ha in 62 countries. This includes 104 certificates and 5,572,553 ha in 10 countries in South America (Forest Stewardship Council 2005). FSC is generally considered the "greenest" of the various systems based on its creation by World Wildlife Fund and the Rainforest Action Network, as well as its strong focus on environmental protection and social concerns. Brazil and Bolivia have the largest FSC certified areas in South America, followed by Chile (Table 1).

Table 1. Total Forest Certification for FSC in South America, 2005

Country	**Hectares**	**# Certificates**
Argentina	131,214	8
Bolivia	1,537,832	15
Brazil	3,034,066	52
Chile	483,843	16
Colombia	58,444	2
Ecuador	21,341	2
Paraguay	61,133	2
Peru	26,936	1
Uruguay	75,094	5
Venezuela	139,650	1
TOTAL	5,572,553	104

Source: Forest Stewardship Council 2005

With the implementation of the Brazilian and Chilean certification schemes, substantial areas of industrial forests, mostly plantations, have been certified in those countries. CerFlor in Brazil and CertFor in Chile are strongly supported by the forest industry in each country. In total, they are anticipated to enroll millions of acres within a few years. To date, 1.8 million ha are enrolled in CertFor and 0.4 million ha in CerFlor. In addition, several major firms in Uruguay, Argentina, Chile, and Brazil have received ISO 14001 certification. This includes at least 127,000 ha in Uruguay and 233,000 ha in Argentina that are not certified under other forest certification systems. Most of the 1.8 million ha of CertFor in Chile also is ISO 140001 certified, and probably much is ISO certified in Brazil as well.

The FSC framework for evaluating sustainable forest management consists of ten Principles and associated Criteria that focus on social, economic and ecological issues. The individual principles cover (Forest Stewardship Council 2000): (1) compliance with laws and FSC principles, (2) tenure and use rights and responsibilities, (3) indigenous people's rights, (4) community relations and worker's rights, (5) multiple benefits from the forest, (6) environmental impact (biodiversity), (7) management plans, (8) monitoring and assessment, (9) maintenance of high conservation value forests, and (10) plantations.

The Brazilian Certificacão Florestal (CerFlor) certification program encompasses five broad principles: (1) compliance with the law, (2) rationality in management and forest resources striving for sustainability, (3) care for biological diversity, (4) care for air, water, and soil resources, and (5) socio-economic and environmental development (Inmetro 2003). The Chilean Certificacion Forestal (CertFor) has nine fundamental Principles, translated roughly as follows: (1) sustainable forest management planning, (2) native ecosystem values and biodiversity protection, (3) productivity and protection from damaging agents, (4) water quality protection, (5) respect for community rights and assistance in developing the quality of life, (6) respect for agreements and indigenous rights, (7) respect for workers rights, health, and fair pay, (8) respect for laws, regulations, and treaties of Chile, and (9) evaluation and improvement of the preceding principles (CertFor 2003).

Each of these three systems have strong components related to environmental protection, community rights, and worker relations and protection. FSC is probably the 'greenest' and strictest regarding high conservation value forests, justification for plantations, and a complete ban on genetically modified organisms (GMOs). FSC is considered most rigorous for community benefits, but CerFlor and CertFor have many of these principles as well. FSC has certified a large area of forest plantations in Latin America. The implementation of CerFlor and CertFor is indeterminate since they are new, but the standards are strict.

Sustainable Forest Management Criteria and Indicators

In addition to forest certification, multi-country and multilateral initiatives have led to the development of regional and international criteria and indicators for measuring and monitoring success in achieving sustainable forest management (SFM). SFM criteria are large-scale reflections of publicly held key forest values, while indicators are means for measuring forest conditions and tracking subsequent changes in them. Sustainable forest management criteria and indicators (SFM C&I) are usually tools for assessing forest conditions and sustainability at national and regional levels, not performance standards for certifying forest management.

The regional and international SFM C&I processes are being used to characterize sustainable forest management; coordinate data collection, storage, and dissemination; monitor and assess the trends in forest conditions; and inform decision-making. These efforts are supported by a number of international organizations (e.g. the Food and Agriculture Organization, the International Tropical Timber Organization, the Center for International Forestry Research) (Montreal Process 2003b).

As of 2003, close to 150 countries were participating in at least one of nine international and regional processes to develop, implement, and use SFM C&I. Today, the principal SFM C&I initiatives that are active and making progress are the Montreal Process for temperate forests, the International Timber and Trade Organization (ITTO) guidelines for tropical forest products producers and global forest products consumers, the Helsinki Protocol for European forests, the Tarapoto Process for the Amazon Basin, and the Dry Forest Asia Process. Here we will discuss the Montreal Process, the ITTO initiative and the Tarapoto Process.

Of the nine criteria and indicator initiatives worldwide, the Montreal Process (2003a) is geographically the largest, encompassing most of the world's temperate and boreal forests, and 60% of all of the world's forests (http://www.mpci.org). The 12 current signatory countries of the Montreal Process include Argentina, Australia, Canada, Chile, China, Japan, the Republic of Korea, Mexico, New Zealand, Russia, Uruguay, and the U.S.A. Together, they account for 45 percent of world trade in wood and wood products about half the world's population.

The International Tropical Timber Organization (ITTO) has been developing SFM C&I for more than a decade and is considered a pioneer in the field. Their work has evolved through a series of guidelines, each developed within a framework of criteria and indicators. These include Guidelines for the Sustainable Management of Tropical Forests (1990), Guidelines for the Establishment and Sustainable Management of Planted Tropical Production Forests (1993), Guidelines for the Conservation of Biological Diversity in Tropical Production Forests (1993), and Guidelines on Fire Management in Tropical Forests (1997). By 1999, ITTO had updated many of their guidelines to help apply and understand SFM and had produced manuals to facilitate the implementation, evaluation and reporting related to the revised C&I. In late 2004, ITTO again revised its C&I for natural tropical forests, retaining the essence of the original seven criteria, but modifying some language to make them more compatible with other international initiatives. They also reduced the number of indicators from 89 to 56 (ITTO 2005).

In terms of C&I, ITTO is primarily focusing current efforts on national-level training to introduce its FMU-level guidelines to forest practitioners in tropical countries (Elías 2004). As of December 2004, 13 workshops had been convened, "providing training to nearly 600 professionals responsible for or working in forest management units" throughout the tropics (ITTO 2005).

The Tarapoto Process for Amazonian Forests was first developed in 1995 by the Amazonian Cooperation Treaty Organization (ACTO) countries (Brazil, Bolivia, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela). The proposal included 12 criteria and 77 indicators for application at global, national, and FMU levels. In its development, the participating countries sought to encompass the distinct environmental, social and cultural characteristics of the Amazonian Basin (Carazo 1997). Between 1196 and 2000, validation exercises were conducted throughout the region to evaluate the relevance and applicability of the C&I with regard to national conditions, needs and priorities (FAO/LACFC 2000). Based on these exercises, a revised set of C&I was developed in 2001. Today, the ACTO countries are in the process of validating a subset of 15 national-level indicators to be introduced into public policies as a verification or reference tool to Amazonian forest sustainability (ACTO 2005).

National Forestry Laws and Agencies

Despite being the principal means of developing and implementing policies to manage and protect forests for decades, information on national forestry laws and agencies is actually more difficult to find and summarize than that on international accords or on forest certification systems. Table 2 summarizes our initial attempts to simply identify the principal agency responsible for forestry in South America and their principal statutory authority. Details on forest policy and agencies for a select few countries follow.

Argentina has no explicit forest policy expressed in terms of a national forestry plan. Law 25.080 on Investments for Planted Forests requires environmental impact studies and monitoring for forest related initiatives receiving state incentives. Provincial laws encompass protection of forest land and call for management plans before forest concessions are awarded. Jurisdiction over national forestry matters is divided among several organizations including the Secretariat for the Environment and Sustainable Development, the Secretariat for Agriculture, Food, Fishing, and Cattle Industry, the National Institute of Farming Technology, and the Timber and Related Industries Research and Technology Center (CITEMA).

Table 2. Summary of National Forestry Agencies and Laws

Country	**Primary Forestry Agency**	**Key Statutory Authority**
Argentina	Secretariat for the Environment and Sustainable Development	No explicit national forestry law, Law 25.080 on Investments for Planted Forests
Bolivia	Forest Supervisory Authority	Forest Law 1700
Brazil	Brazilian Institute of the Environment	Forest Law 1700, Law 4.771/65
Chile	National Forest Corporation	No explicit national forestry law
Colombia	Forest Policy Advisory Committee	National Council for Economic and Social Planning Legal Document 2.834
Ecuador	The National Forest Directorate	Law on Forests and the Conservation of Natural Areas and Wildlife (1982 and amendments)
French Guiana	Guyana Forestry Commission	Forest Act of 1973, National Forest Policy 1997
Guyana	National Forest Institute, National Council for Protected Areas	National Forest Policy, National Protected Areas Policy of 1999
Paraguay	National Forest Service	Forest Law 422, Resolution 11681 and

		18831
Peru	National Institute of Natural Resources	Forest and Wildlife Law of 2000
Suriname	Ministry of Natural Resources	Forest Management Act of 1992
Uruguay	General Directorate of Forests	Law 17234, National Forestry Plan of 2000
Venezuela	General Directorate of Forest Resources	Forest Law, Forest Soils and Water Law

In Bolivia, a National Code of Forest of Practices was established under Forest Law 1700 in 1996, which aims to regulate the sustainable use and protection of forested lands. The Strategic Plan for Forest Development is a component of Bolivia's General Plan for Economic and Social Development intended to support forests' contribution to increasing the GDP and improving forest stakeholder's standard of living. The Ministry of Sustainable Development and the Environment is in charge of implementing the Forest Code as the national policy-making institution, the Forest Supervisory Authority is the regulatory institution and the National Forest Development Fund is the designated financial institution. Prefectures and municipalities also provide support to forest related governance.

Article 225 of Brazil's Federal Constitution of 1988 covers the environmental aspects of forest resources. Articles 24 and 175 specifically cover forest management. Law 4.771/65 encompasses the National Code of Forest Practices. Forest policy is set by the Ministry of the Environment through the Directorate of the National Forest Program. The Brazilian Institute of the Environment (IBAMA) is responsible for implementation of forest related policies at the federal level. States are given the responsibility of administering forest resources under their jurisdiction.

Paraguay established a forest policy in 1972 through Forest Law 422. Later resolutions (i.e. 11681 and 18831) placed increased importance on the forestry sector as a contributor to the GDP and reinforced rules and regulations on forest harvesting. Paraguay also implemented an aggressive national reforestation program through agricultural sector reforms 2002. The National Forest Service is in charge of the administration of forest resources, and jointly oversees forest project approval with the General Directorate of Environment and Natural Resource Quality and Control and with the General Directorate of Biodiversity Protection and Conservation.

In Peru, the Forest and Wildlife Law was established in 2000, with related regulations published in 2001. A highly participatory process led to the development of the National Forest Development Strategy for 2002-20021. The National Institute of Natural Resource is the state forestry authority, which is a decentralized public agency of the Ministry of Agriculture. Since 2001, the National Institute of Natural Resources has implemented various institutional instruments dedicated to forest development, such as the National Fund for Forest Development and Promotion, the Ad Hoc Commission for Forest Concessions, and the Supervisory Body for Timber Forest Resources.

Discussion and Conclusions

The Americas contain about 38% of the world's forests, and Brazil has about 38% of all the forests in the Americas and 14% of all the forests in the world. Forest loss continues to be significant in Central and South America. Means to prevent these losses range from markets to pubic intervention. Three possible approaches for forest protection include the market-based approach of forest certification, the national approach of forestry laws and regulations, and the international agreements with national implementation, represented by Sustainable Forest Management Criteria and Indicators.

The most widespread and oldest approach to forest resource management and protection, except for laissez-faire, has been through the passage and implementation of national forestry laws. This may consist of broad national laws that cover forests as an entire sector, or smaller individual laws and regulations that cover various components of forestry ranging from land use and conversion to reforestation incentives and taxes to protection from fire, disease, or pathogens. These laws have formed the basis for policy interventions in the Americas for centuries. They have not, however, prevented continuing attrition in the area of forests, nor in the diminution of valuable native timber species, loss of biodiversity, and other problems. Laws may well have prevented existing problems from becoming worse, and incentives surely have encouraged plantation forests in Latin America, but laws alone have not been a panacea that solves all issues. Implementation is variable, higher land use values overwhelming, enforcement feeble or corrupt, and agency funding dyspeptic. Thus other means have been sought to enhance laws and to prevent loss of forests, timber, and biodiversity, and social benefits.

Sustainable Forest Management Criteria and Indicators for temperate and other forests have been developed in various international agreements. The Montreal Process SFM mandates national measuring and monitoring of progress toward sustainable forestry for a broad range of environmental, economic, and social goods and services. This process is informative, but not prescriptive. It is largely the focus of governments and policy experts, and perhaps forestry researchers and a small number of forest practitioners. To date, SFM is not a strong tool for advocacy, regulation, or encouraging public or private forestry investment per se. Instead, SFM standards may provide a benchmark for forest certification standards and national policies. Explicit connections between most SFM C&I and forest certification standards or national laws have not been made yet in South or North America, although this is pervasive in Europe. Future connections are most likely to be made where government ownership of forest land predominates, which includes most countries in the tropics. SFM C&I are likely to evolve to be instrumental in setting some, but not all, of the national forest policy agenda in most countries, including for laws, incentives, and education efforts. However, this evolution will be slow.

Forest certification, which mandates and audits standards of forestry practice at the stand or ownership level, has potential for a much larger immediate impact on natural and plantation forest management and measurement and protection of biological diversity. Forest certification by FSC requires that managers favor natural stands and biodiversity. The Sustainable Forestry Initiative certification process in North America includes wildlife and biodiversity as major components of its standards. FSC mandates rigorous standards for forest plantations, especially of exotic species, and careful planning to justify how they complement natural forests and are juxtaposed in the forest landscape. Social forestry standards also are important for FSC. The new CerFlor and CertFor approaches also have rigorous standards for both social and environmental components. Compliance with national laws is required under all forest certification systems, which will clearly enhance implementing those laws. Having certified organizations document and comply with national laws can substitute for weak national agency implementation.

The key forest values set forth in national laws, the different SFM C&I, and forest certification systems are related, but differ enough that they are certainly not functionally equivalent across all systems. Indeed it is the differences among systems that make for interesting challenges in determining which is more effective for evaluating particular economic, ecological, environmental, and social criteria for different scales of application. These differences also raise the question of whether or how to modify the systems so that they are more compatible. For example, certification, SFM C&I, and any national standards should rate various aspects of SFM in the same way, and the data generated for certification should feed directly into C&I and/or national standards.

These detailed measurements of forest management practices, combined with prescriptions to protect biodiversity and manage planted forests carefully, will have significant on-the-ground effects on forestry in the Americas. Some forest products firms have become sincere believers and practitioners of forest certification, under either FSC or the nascent Brazil and Chile standards. For example, FSC certified plantation operations have generally set aside more than 25% of their natural forest areas for conservation. Chile has almost 2 million ha of forests certified by CertFor. Our discussions with managers at many major firms indicate that certification has reformed thinking and practices about the economic, ecological, social, managerial, and scientific aspects of sustainable forestry. While some of this is rhetoric, the new view toward forestry is being imbued throughout the organizations as the certification standards trickle down to most employees and operations.

Furthermore, forest certification audits are performed by major international firms. The reputation of these firms depends on their transparency, independence, and rigor. The audits require rigorous evaluation of environmental management systems, forest policies, and forest practices to meet economic, ecologic, and social standards. Establishing and implementing a quality program to meet the detailed forest certification standards is absolutely required to successfully pass the external audits.

The continued application of SFM criteria and indicators and various forest certification schemes will enhance data collection, scrutiny, management, and protection of biodiversity throughout the world. At the same time, SFM and forest certification offer promise for the continued social imprimatur to grow and manage intensive forest plantations under reasoned guidelines and standards. They also can strengthen national programs by increasing interest and support for forest production and protection in general. In total, national laws, international SFM C&I, and private forest certification approaches promise to continue to enhance forest management, forest protection, and social benefits in the Americas in the future.

Literature Cited

ACTO. 2005. Amazonian Countries debate Forestry Sustainability Indicators. Available at: http://www.otca.org.br/en/noticia/noticia.php?idNoticia=363&tipoN=7. 23 November 2005.

Carazo, V. 1997. Analysis and prospects of the Tarapoto proposal: criteria and indicators for the sustainability of the Amazonian forest. In: Proceedings of the XI World Forestry Congress. Antalya, Turkey, October 13 – 22, 1997.

CertFor. 2003. Estandar CertFor. Available at: http://www.certfor.org/estandar.htm. 4 November 2003.

Elías, E. 2004. The Tarapoto Process: establishing criteria and indicators for the sustainable management of Amazon forests. Unasylva 218 (55):

FAO. 2003. State of the world's forests, 2003. Food and Agriculture Organization of the United Nations. Rome. 243 p.

FAO. 2002. Yearbook of Forest Products. FAO Forestry Series No. 35. FAO Statistics Series No. 158. Food and Agriculture Organization of the United Nations. Rome. 243 p.

FAO/LACFC. 2000. Review of FAO regular and field programmes, including follow-up to the recommendations and requests of the 20th session of the commission. Secretariat Note presented at: Latin American And Caribbean Forestry Commission Twenty-First Session, Bogota, Colombia, September 4-8, 2000.

Forest Stewardship Council. 2000. FSC Principles and Criteria. Document 1.2, Revised February 2000. Accessed at: http://www.fscoax.org/html/1-2.html. 14 September 2003.

Forest Stewardship Council. 2005. Forests certified by FSC-Accredited Certification bodies, January 31, 2005. Accessed at: http://www.fscoax.org. 15 March 2005.

INMETRO. 2003. Cerflor: Certificação Florestal. Accessed at: http://www.inmetro.gov.br/qualidade/cerflor.asp. 4 November 2003

ITTO. 2005. The International Tropical Timber Organization. Accessed at: http://www.itto.or.jp/ 16 November 2005.

Montreal Process. 2003a. The Montreal Process. http://www.mpci.org. Accessed on 6 July 2003.

Montreal Process. 2003b. Montreal Process First Forest Overview Report 2003. 20 p.

Concurrent Session 1C: Economics of the Forest Products Industry

Price Linkages in the North American Softwood Lumber Market

Jungho Baek[1]

[1] Research Assistant Professor, Center for Agricultural Policy and Trade Studies, Department of Agribusiness and Applied Economics, North Dakota State University, Fargo, ND 58105; Phone: (701) 231-7451; Fax: (701) 231-7400; Email: jungho.baek@ndsu.nodak.edu.

Price Linkages in the North American Softwood Lumber Market

Abstract

This paper examines structural changes and the dynamics of price relationships in the U.S., British Columbia, Quebec and Ontario lumber markets. With monthly price series from 1981 to 2002, we use Perron's method to identify structural shifts and the Johansen cointegration analysis and vector-error correction (VEC) model to determine both short-run and long-run price relationships. We find that, due to restrictions on federal timber harvests in the Pacific Northwest (PNW), price instability experienced in 1992 has caused structural shifts for the U.S. and Canadian lumber prices. We also find that the North American lumber market is indeed integrated where the U.S. price significantly affects Canadian prices in both short-run and long-run. This result indicates the price leadership role for the U.S. in the North American lumber market where the Canadian prices respond to the U.S. price change, but that the reverse does not hold. Therefore, this finding may not support the claim of U.S. producers that subsidized Canadian lumber has depressed the U.S. price and harmed the U.S. lumber industry.

Key Words: cointegration analysis, structural changes, vector-error correction

Introduction

The trade of softwood lumber between the U.S. and Canada is one of the major trade flows of forest products in the world. These two countries are not only the world's largest producers of softwood lumber, but also the world's largest importer and exporter, respectively. For example, in 2002, the U.S. shared 45% of world imports for softwood lumber, while Canada provided 48% of world lumber exports (FAO 2003). More importantly, the U.S. and Canada are highly interdependent on each other's lumber market. The U.S. depends on Canada for more than 90% of its lumber imports. Canada exports more than 60% of its lumber production to the U.S. Given the economic importance of lumber trade between the two countries, therefore, it is important to clearly understand the behavior of softwood lumber markets in North America.

Several studies have examined price relationships in either the U.S. or Canadian lumber markets. Uri and Boyd (1990) use the concept of the Granger causality in order to detect the geographical extent of the U.S. lumber markets. They find that the demand for softwood lumber is indeed strongly connected to prices, and that there is a national lumber market in the U.S. Jung and Doroodian (1994) adopt the Johansen cointegration procedure to identify the long-run equilibrium relationships among four U.S. regional lumber markets. They discover that, with efficiently linked prices, there exists a single long-run equilibrium price in the U.S. lumber market. More recently, with the most disaggregate data and a large number of price combinations for different products, Yin and Baek (2005) test the law of one price (LOP) hypothesis for the U.S. lumber markets. After exhaustive investigations, they find overwhelming evidence supporting the LOP for the entire U.S. market. Similarly, a Canadian scholar uses the Johansen procedure to test the LOP hypothesis for five Canadian regional lumber markets (Nanang 2000). With the single cointegration vector identified, he concludes that there is no single market for softwood lumber in Canada.

Previous studies have undoubtedly expanded our understanding of the price relationships in the U.S. and Canadian lumber markets. However, earlier studies have examined either the long-run price relationships based on the concept of cointegration or the short-run price dynamics based on the concept of Granger causality; therefore, little attention has been paid to conduct the rigorous study of long-run and short-run price relationships simultaneously. In other words, no studies have examined as to how equilibrium relationships are restored and what new equilibrium levels would be obtained given policy shifts. Further, no study so far has dealt with price relationships in the U.S. and Canadian lumber markets together. With the recent development of the lumber trade dispute, it is timely to explore this relationship.[2]

One objective of this paper is to assess the dynamics of price relationships in the North American lumber market. To that end, we examine short-run and long-run price relationships in three

[2] Since the early 1980s, a number of lumber trade disputes have arisen between the U.S. and Canada. The very latest trade dispute between the two countries has come as a result of the expiration of the Softwood Lumber Agreement (SLA). In April 2001, U.S. producers filed countervailing and antidumping petitions, which claimed that subsidized and below-cost Canadian lumber was being dumped on the U.S. market, harming the U.S. lumber industry. The International Trade Commission (ITC) issued its finding that the U.S. lumber industry is threatened with material injury by imports of Canadian lumber. As a result, in May 2002, the U.S. government imposed the countervailing (18.79%) and antidumping (8.43%) duties on Canadian lumber exported to the U.S.

Canadian provincial and one national U.S. lumber markets using the Johansen cointegration analysis and vector error-correction (VEC) model. More specifically, previous studies reveal that there exists a single national market in the U.S., since the LOP holds for the entire U.S. markets (Uri and Boyd 1990, Jung and Doroodian 1994, Yin and Baek 2005). As such, the U.S. market is treated as a single market in our models. In contrast, the Canadian provincial markets should be treated as separate markets, since the LOP does not hold for the entire Canadian markets (Nanang 2000). We thus consider the Canadian markets as consisting of three segmented markets such as British Columbia (BC), Quebec, and Ontario in our models. Since these three provinces account for approximately 80% of total Canadian production and approximately 85% of exports to the U.S., it seems reasonable to use them as a representative of Canadian markets in our analysis.

It is essential to understand price relationships in U.S. and Canadian provincial lumber markets in order to address issues of market structure, price leadership, and market modeling. For example, if we find evidence that the Canadian prices respond to disequilibria induced by a shock shifting either U.S. or Canadian price levels, but that the U.S. price does not respond, it suggests that U.S. acts as the price leader and imperfect competition exists in the North American market. On the other hand, if U.S. and Canadian lumber prices are cointegrated, it indicates that these prices tend to drift in a similar fashion in the long-run, and the cointegration relationships should be included in modeling the North American lumber market; otherwise, the econometric models could give a biased estimation. More importantly, it is important to assess the price relationship to understand the on-going lumber trade dispute between the U.S. and Canada. For example, the finding of U.S price leadership indicates that the Canadian markets are influenced by the U.S. market, but that the reverse does not hold. This further suggests that Canadian subsidies, if exists, may not have an impact on price changes in the U.S. market. As such, the U.S. claim that subsidized Canadian lumber, particularly coming from the three provinces, has depressed the U.S. prices would not be supported.

A second objective of this paper is to use the concept of structural change to identify structural breaks in the U.S. and Canadian prices series. Structural change is an important issue in time-series analysis and affects all the inferential procedures associated with unit roots and cointegration tests (Maddala and Kim 1998). Specifically, unit root tests are prerequisite to construct an appropriately specified VAR model. However, assuming that the deterministic trend is correctly specified, the standard augmented Dickey-Fuller (ADF) test is not able to detect a structural break in the series (Maddala and Kim 1998). As such, if there is a break in the deterministic trend, then ADF test may have lower power and even could lead to a false conclusion that there is a unit root, when in fact there is not (Perron 1989). Hence, tests for structural changes are performed to overcome the shortcomings of the standard ADF procedure, as well as to examine whether there is any evidence of structural breaks in the lumber prices series. It is hoped that this analysis will shed new light on the dynamics of price relationships in both U.S. and Canadian lumber markets and contribute to the literature of forest products markets.

The paper is organized in five sections. The next section describes the data used for the analysis. The unit root test under structural change is then discussed, followed by the main empirical results of the study. A summary of principal findings and conclusions of the research are included in the final section.

Data

Monthly softwood lumber prices for U.S. (US_t), British Columbia (BC_t), Quebec (QE_t), and Ontario (ON_t) are collected for the period of January 1981 to April 2002. All price series are quoted in industry price indexes for softwood lumber (1997=100), because actual lumber prices in British Columbia, Quebec, and Ontario are not available. Price index for the U.S. is collected from Bureau of Labor Statistics in the U.S. Department of Labor. Price indexes for the three Canadian provinces are taken from the CANSIM database (Industry Price Indexes Table 329-0043) from Statistics Canada.

Structural Change and Unit Root Tests

Theoretical Framework

To take into account structural changes in the deterministic trend function, Perron (1989) develops a modified augmented Dickey-Fuller (ADF) test for the presence of a unit root with three alternative models. Given a known structural break, the approach is generalized to allow a one-time change in the structure occurring at a time T_B, referred to as the time of break. The three different models are parameterized as follows:

(1) Model (A): $y_t = \mu_0 + \delta t + \mu_1 DU_t + u_t$

where $DU_t = 1$ if $t > T_B$, and 0 otherwise.

(2) Model (B): $y_t = \mu + \delta_0 t + \mu_1 DT_t^* + u_t$

where $DT_t^* = 1$ if $t = T_B + 1$, and 0 otherwise.

(3) Model (C): $y_t = \mu_0 + \mu_1 DU_t + \delta_0 t + \delta_1 DT_t + u_t$

where $DT_t = t$ if $t > T_B$, and 0 otherwise.

Model (A) is referred to as the crash model and allows for a one-time change in the intercept of the trend function. Model (B) is known as the changing growth model and considers a change in the slope of the trend function without any sudden change in the intercept. Model (C) allows for both effects (slope and intercept) to take place simultaneously.

For empirical analysis, the three different models are reformulated by nesting the corresponding models under the null and alternative hypotheses as follows:

(4) Model (A): $y_t = \mu^A + \beta^A t + \theta^A DU_t + \gamma^A TB_t + \alpha^A y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t$

(5) Model (B): $y_t = \mu^B + \beta^B t + \theta^B DU_t + \delta^B DT_t^* + \alpha^B y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t$

(6) Model (C): $y_t = \mu^C + \beta^C t + \theta^C DU_t + \gamma^C TB_t + \delta^C DT_t + \alpha^C y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t$

where $TB_t = 1$ if $t = T_B$, and 0 otherwise. The null hypothesis of a unit root imposes the restrictions on the parameters of each model as follows: $\alpha^A = 1, \beta^A = 0$, and $\theta^A = 0$ in Model (A) ; $\alpha^B = 1$, $\beta^B = 0$, $\gamma^B = 0$ in Model (B) ; and $\alpha^C = 1$, $\beta^C = 0$, and $\gamma^C = 0$ in Model (C). Finally, under the null hypothesis, γ^A, γ^C and θ^B are expected to be significantly different from zero.

Identifying Structural Change

To motivate the use of three different models developed by Perron (1989), we first present graphical investigation for the four price series (Figure 1). The graph of the U.S. price series shows that there appears to be both change in the intercept of the series in the early 1992 and the slope afterwards (first Figure). The same feature appears to hold for the BC and Quebec prices in the late 1992 (second and third Figures). Those three price series thus behave in correspondence to Model C. On the other hand, the Ontario price series behaves according to Model A where there is no sharp change in the slope in the late 1992 but rather a change in the intercept (fourth Figure). To verify this graphical examination, we use ordinary least squares (OLS) to estimate equations (1) and (3) (Models A and C) for potential break points (T_B) in the neighborhood of graphically inspected break dates.[3] Given the OLS assumption, the values of T_B which minimize the sum of squared residuals are the maximum likelihood estimates of the time at which the structural change occurs, referred to as grid search (Oehmke and Schimmelpfennig 2004). The resulting break points are January 1992 for the U.S. price, November 1992 for the BC and Quebec prices, and December 1992 for the Ontario price.

[3] We test for a break in the three-year neighborhood of a suspected break.

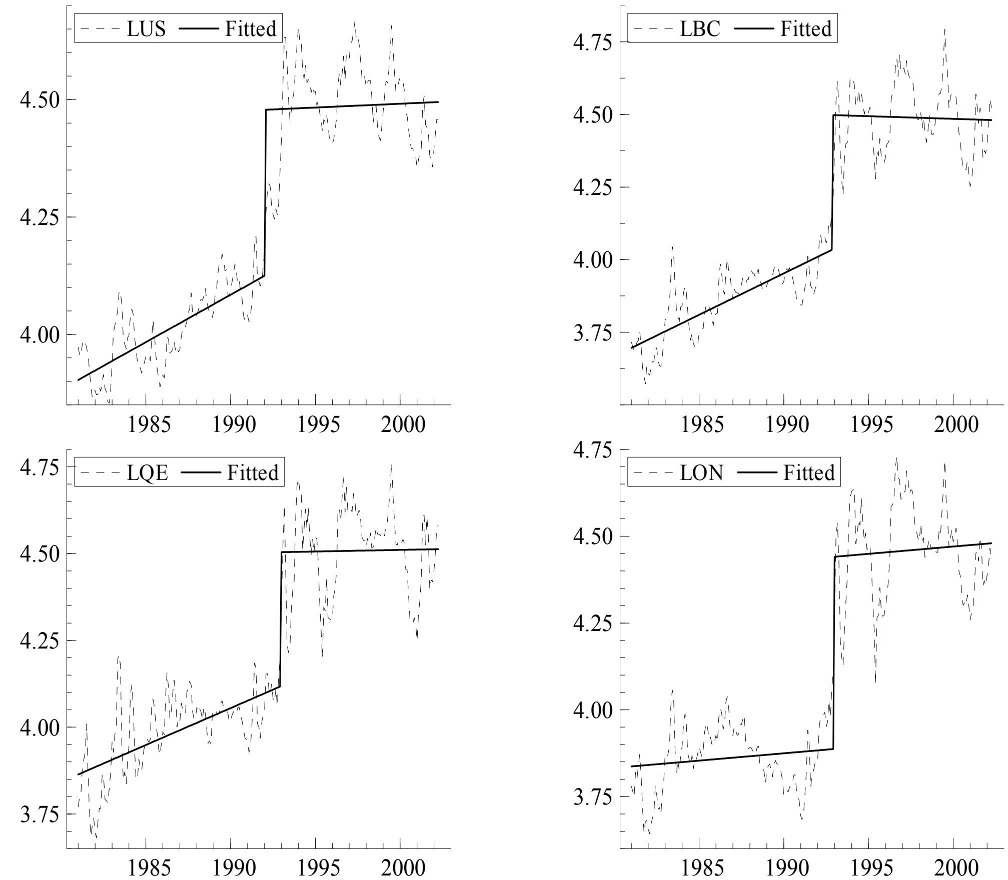


Figure 1. Logarithm of U.S., BC, Quebec and Ontario prices, actual values and modeled structural shifts (fitted values), 1981-2002

With the maximum likelihood estimates for break points (T_B^*), we then test for statistical significance of the parameters in equations (1) and (3) (Table 1). The results show that all regressions have high adjusted R^2, above 0.96. The coefficients on the intercept, trend, and intercept- and trend shifts in the U.S., BC, and Quebec price series are significant at the 1% level. Additionally, the coefficients on the intercept, trend, and intercept shift in the Ontario price are significant at least at the 10% level. The OLS results thus indicate that the incorporation of DU_t and DT_t in the model is statistically important. For completeness, we use the estimated models to generate fitted values (solid lines) of the dependent variables (Figure 1). These figures provide graphical validation of the structural changes obtained from the regression results. The break points found here coincided with the federal timber harvest reductions in the Pacific Northwest (PNW), which created a dramatic price shock and thus has had a significant effect on the U.S. and Canadian lumber prices.

Table 1. OLS regression results on structural shifts in U.S. and Canadian lumber prices

Independent variable (t-statistic)	Dependent variable			
	$\ln(US_t)$	$\ln(BC_t)$	$\ln(QE_t)$	$\ln(ON_t)$
Intercept	3.9013***	3.6936***	3.8619***	3.8365***
	(284.0)	(222.0)	(212.0)	(228.0)
Intercept shift	0.3534***	0.4644***	0.3871***	0.5534***
	(17.9)	(18.7)	(14.1)	(19.5)
Trend	0.0017***	0.0024***	0.0018***	0.0004*
	(9.44)	(11.9)	(8.11)	(1.84)
Trend shift	-0.0016***	-0.0025***	-0.0017***	-
	(-5.77)	(-7.27)	(-4.39)	
Time of shift	1992:01	1992:11	1992:11	1992:12
Observation	256	256	256	256
Adjusted R^2	0.97	0.97	0.96	0.97

Note: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively; Both intercept and trend shifts occur in the U.S., BC, and Quebec prices, while only intercept shift occurs in the Ontario price.

Testing for Unit Roots under Structural Change

To test for unit roots in the presence of structural shifts, we estimate equation (4) for the Ontario price and equation (6) for the other three series (Table 2). For comparison, we also estimate the standard ADF statistics for the series. The results show that the null hypothesis of non-stationarity cannot be rejected for all four series with the ADF test. In contrast, when structural shifts are included, the null hypothesis can be rejected at least at the 10% significance level for all the series. The results thus indicate that the underlying process for the U.S. and three Canadian prices can be characterized by stationary fluctuations around a deterministic trend function.

Given that the null hypothesis of non-stationarity can be rejected for all the series, it is no longer appropriate to use the full sample in our cointegration analysis. We then divide the full sample into two sub-samples according to the break point (pre- and post- 1992:12) in order to see if this feature is stable in both cases.[4] However, it is widely known that when dealing with finite samples, especially small numbers of observations, the power of the standard ADF test is notoriously low (Harris and Sollis 2003). In other words, the ADF test has high probability of accepting the null hypothesis of non-stationarity when the true data-generating process is in fact stationary. Consequently, we use more powerful tests for the two sub-samples.

[4] We split the full sample at the 1992:12 break point, since all the series have experienced structural shifts between 1992 and 1993.

Table 2. ADF and Perron tests for a unit root

# of lags	$\ln(US_t)$		$\ln(BC_t)$		$\ln(QE_t)$		$\ln(ON_t)$	
	ADF	Perron	ADF	Perron	ADF	Perron	ADF	Perron
2 lags	-2.77	-5.13***	-3.23	-5.87***	-3.32	-6.50***	-2.99	-5.36***
4 lags	-2.07	-4.47**	-2.44	-5.00***	-3.19	-5.24***	-2.20	-4.33**
6 lags	-1.70	-4.09*	-2.62	-5.23***	-2.92	-4.91***	-2.10	-4.16**
8 lags	-1.51	-3.97*	-2.61	-4.85**	-2.32	-4.45**	-1.89	-4.14**

Note: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively; The 1%, 5%, and 10% critical values for the ADF including a constant and a trend are -4.90, -4.24, and -3.96, respectively; The 1%, 5% and 10% critical values for the Perron test are -4.90, -4.24, and -3.96 for Model C, and -4.45, -3.76, and -3.47 for Model A. Critical values are obtained from Tables 4B and 6B in Perron (1989).

Elliott et al. (1996) develop a unit root test which is well suited to our situation. They optimize the power of the ADF test using a form of detrending, referred to as Dickey-Fuller generalized least squares (DF-GLS) detrended test. “Monte Carlo experiments indicate that the DF-GLS works well in small samples and has substantially improved power when an unknown mean or trend is present” (Elliott et al. 1996, p. 813). Ng and Perron (2001) recently have produced a testing procedure which incorporates both the new information criterion for setting the lag length and GLS detrending. The results show that, with the pre-1992:12 sample, the rejection of non-stationarity for the BC and Quebec prices is consistent across different lag lengths at the 5% or better significance level, indicating that these two prices are stationary (Table 3). In contrast, the null hypothesis cannot be rejected for all the series in the post-1992:12 sample.

Kwiatkowski et al. (KPSS) (1992) argue for the usefulness of performing tests of the null hypothesis of stationarity as well as tests of the null hypothesis of a unit root, particularly when using non-stationarity tests with low power. With the null hypothesis of stationarity, either around a level or around a linear trend, the KPSS test thus can be used as a complement to standard unit root tests. If the DF-GLS and KPSS tests provide different results, the tests are inconclusive. We first estimate the KPSS statistics for no trend models. The results show that the KPSS test unambiguously rejects the null hypothesis of stationarity for all the series in both sub-samples. We then proceed to test the null hypothesis of trend stationarity. The results indicate that the KPSS test fails to reject the null for the BC and Quebec prices in the pre-1992:12 sample (Table 3). On the other hand, with the post-1992:12 sample, the null hypothesis can be rejected for all the series.

From the findings of the DF-GLS and KPSS tests, we conclude that the U.S. and Ontario prices in the pre-1992:12 sample and all price series in the post-1992:12 sample are non-stationary. However, since the BC and Quebec prices are consistently found to be stationary in the pre-1992:12 sample, they cannot be used for the cointegration analysis.[5] Therefore, for further time-series analysis, we decide to focus our attention on the post-1992:12 sample.

[5] Of course, we can use two non-stationary variables such as the U.S. and Ontario prices for our cointegration analysis. However, only using two price series is not sufficient and thus meaningful to our understanding of the

Table 3. DF-GLS test for the null hypothesis of non-stationarity and KPSS test for the null hypothesis of trend stationarity.

# of lags	DF-GLS test							
	Sub-sample I (1981:01-1992:12)				Sub-sample II (1993:01-2002:04)			
	$\ln(US_t)$	$\ln(BC_t)$	$\ln(QE_t)$	$\ln(ON_t)$	$\ln(US_t)$	$\ln(BC_t)$	$\ln(QE_t)$	$\ln(ON_t)$
2 lags	-2.61	-3.97***	-4.83***	-2.47	-1.45	-1.76	-2.14	-1.72
4 lags	-2.02	-3.27**	-4.39***	-2.04	-0.92	-1.28	-1.56	-1.06
6 lags	-1.43	-3.17**	-3.30**	-1.77	-0.83	-1.37	-1.50	-1.05
8 lags	-1.07	-3.36**	-2.99**	-1.51	-0.84	-1.18	-1.30	-1.00

Lag order	KPSS test							
	Sub-sample I (1981:01-1992:12)				Sub-sample II (1993:01-2002:04)			
	$\ln(US_t)$	$\ln(BC_t)$	$\ln(QE_t)$	$\ln(ON_t)$	$\ln(US_t)$	$\ln(BC_t)$	$\ln(QE_t)$	$\ln(ON_t)$
0	0.794***	0.451***	0.448***	1.26***	1.84***	1.82***	1.55***	1.94***
1	0.422***	0.241***	0.248***	0.667***	0.95***	0.942***	0.816***	1.00***
2	0.3***	0.172**	0.186**	0.469***	0.655***	0.649***	0.57***	0.693***
3	0.24***	0.139*	0.158**	0.37***	0.508***	0.503***	0.448***	0.538***
4	0.206**	0.119*	0.142*	0.31***	0.42***	0.417***	0.375***	0.446***
5	0.184**	0.106	0.132*	0.269***	0.362***	0.359***	0.326***	0.384***
6	0.169**	0.0973	0.125*	0.239***	0.32***	0.317***	0.291***	0.339***
7	0.158**	0.0906	0.12*	0.216***	0.288***	0.286***	0.264***	0.305***
8	0.149**	0.0855	0.115	0.198**	0.264***	0.262***	0.243***	0.279***
9	0.142*	0.0815	0.109	0.183**	0.244***	0.243***	0.225***	0.257***
10	0.136*	0.0784	0.104	0.17**	0.228***	0.227***	0.211**	0.24***
11	0.132*	0.076	0.0994	0.16**	0.215**	0.214**	0.2**	0.226***
12	0.128*	0.0743	0.0959	0.151**	0.204**	0.204**	0.19**	0.214**
13	0.125*	0.0731	0.0924	0.144*	-	-	-	-

Note: ***, **, and * denote rejection of the null hypothesis at the 1%, 5%, and 10% levels, respectively; The 1%, 5%, and 10% critical values for the DF-GLS test are -3.53, -2.99, and -2.70 for sub-sample I, and -3.56, -3.02, and -2.73 for sub-sample II; The 1%, 5%, and 10% critical values for the KPSS test of trend stationary are 0.216, 0.146, and 0.119 for both samples. To save space, the results for the hypothesis of level stationarity are not reported; The lag order for the KPSS test is chosen by Schwert criterion.

Cointegration Test and Error-Correction Model

Theoretical Framework

A long-run equilibrium price relationship between two markets can be represented as follows:

(7) $P_{it} = \alpha + \beta P_{jt} + u_{ijt}$

---

price relationships in the North American lumber market. Hence, we decided to exclude the pre-1992:12 sample for cointegration analysis.

where P_{it} and P_{jt} are prices for market i and j; α and β are estimated coefficients; and u_{ijt} is a normally and independently distributed error term. The long-run equilibrium relationship between markets i and j can be detected by estimating β. In our case, price series are non-stationary. The OLS regression between such series thus leads to a spurious regression problem (Wooldridge 2000). To avoid this problem, we use the cointegration procedure. Engle and Granger (1987) show that even in the case that all the variables in a model are non-stationary, it is possible for a linear combination of integrated variables to be stationary. In this case, the variables are said to be cointegrated and the problem of spurious regression does not arise.

The Johansen maximum likelihood estimation method is used to determine the number of cointegration relationships among the price series (Johansen and Juselius 1990, Johansen 1995). Following Johansen, the cointegrated vector auto-regression (VAR) model can be defined as follows:

(8) $$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + ... + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + u_t$$

where X_t is a ($1 \times n$) vector of endogenous variable; i.e., $X_t = [US_t, BC_t, QE_t, ON_t]$; Δ is the difference operator; $\Gamma_1,...,\Gamma_{k-1}$ are the coefficient matrices of short-term dynamics, and $\Pi = -(I - \Pi_1 + ... + \Pi_k)$ are the matrix of long-run coefficients; μ is a vector of constant; and u_t is white noise. Granger's representation theorem asserts that if the coefficient matrix Π has reduced rank $r < n$, then there exist ($n \times r$) matrices of α and β, each with rank r such that $\Pi = \alpha\beta'$ and $\beta' X_{t-k}$ is stationary (Engle and Granger 1987). Here, r is the number of cointegrating relations, α represents the speed of adjustment to equilibrium, and β' is a matrix of long-run coefficients. For n endogenous non-stationary variables, there can be 0 to $n-1$ linearly independent cointegrating relations in the system. The number of cointegration vectors, the rank of Π, in the model is determined by the likelihood ratio test (Johansen 1995).

If all variables in a vector of stochastic process X_t are cointegrated, an error-correction representation captures the short-run dynamics while restricting the long-run behavior of variables to converge to their cointegrating relationships (Engler and Granger 1987). This is accomplished by estimating an error-correction model in which residuals from the equilibrium cointegrating regression are used as an error-correcting regressor. For this purpose, equation (8) can be reformulated as a short-run dynamic model as follows:

(9) $$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + ... + \Gamma_{k-1} \Delta X_{t-k+1} + \alpha(\beta' X_{t-1}) + u_t$$

where $\beta' X_{t-1}$ is a measure of the error or deviation from the equilibrium, which is stationary since the series are cointegrated. Since variables are cointegrated, the VEC model incorporates both short-run and long-run effects. That is, if the long-run equilibrium holds, $\beta' X_{t-1} = 0$. During periods of disequilibrium, on the other hand, this term is non-zero and measures the distance of the system from equilibrium during time t; thus, an estimate of α provides information on the speed-of-adjustment, which implies how the variable X_t changes in response to disequilibrium.

Johansen Cointegration Test

The Johansen cointegration procedure is applied to determine the number of cointegrating vectors using the post-1992:12 sample. Prior to the cointegration test, it is necessary to determine the lag length to define a correctly specified VAR model, which ensures the residuals are approximately white noise. For this purpose, a number of VAR lag selection criteria and diagnostic tests are used. The lag lengths (k) of the VAR model are determined by the Schwarz (SC), Hannan-Quinn (HQ), and Akaike (AIC) information criteria using likelihood ratio tests (Doornik and Hendry 1994). For example, we start from k = 8 and a reduction of the VAR from k =8 to k =7 is rejected. This reduction sequence is then conducted until we find that the reduction from k =5 to k =4 is accepted.

Diagnostic tests on the residuals of each equation and corresponding vector test statistics support the VAR model with four lags (k =4; Table 4). In our serial correlation test using the F -form of the Lagrange Multiplier (LM) test, the null hypothesis of no serial correlation cannot be rejected at the 1% significance level. Heteroskedasticity is tested using the F -form of the LM test and the null hypothesis of no heteroskedasticity cannot be rejected at the 1% significance level. Normality of the residuals is tested with the Doornik-Hansen (1994) method. The null hypothesis of normality cannot be rejected at the 1% significance level. Furthermore, the specification tests indicate that a linear trend is necessary but seasonal dummies are not.

Table 4. Diagnostic tests with the sub-sample II (1993:01-2002:04)

	Serial Correlation $F_{AR}(7,86)$	Heteroskedasticity $F_{ARCH}(7,79)$	Normality $\chi^2(2)$
ΔUS_t	0.85 [0.55]	0.94 [0.49]	2.05 [0.36]
ΔBC_t	1.43 [0.21]	1.12 [0.36]	3.33 [0.26]
ΔQE_t	1.25 [0.29]	1.65 [0.13]	0.36 [0.83]
ΔON_t	1.36 [0.23]	1.22 [0.16]	1.13 [0.57]
System	1.18 [0.15]	0.87 [0.93]	11.63 [0.17]

Note: Δ denotes the first differences of the variables and parentheses are p -values; Serial correlation of the residuals of individual equations and a whole system is examined using the F -form of the Lagrange-Multiplier (LM) test, which is valid for systems with lagged independent variables; Heteroskedasticity is tested using the F -form of the LM test; Normality of the residuals is tested with the Doornik-Hansen test (Doornik and Hendry 1994).

The results of cointegration estimation indicate three cointegration vectors (r =3) in four price series (Table 5). Specifically, the trace tests show that the hypothesis of r =2 can be rejected and r =3 is accepted. As a result, three cointegration vectors are accepted at the 5% significance level. This suggests that all of the four price series in the North American lumber market are integrated.

Table 5. Johansen cointegration tests with sub-sample II (1993:01-2002:04)

Null hypothesis	Eigenvalue	Trace statistics	5% critical value
H_0: r = 0	0.225	81.45**	62.99
H_0: r ≤ 1	0.199	52.87**	42.44
H_0: r ≤ 2	0.161	27.97**	25.32
H_0: r ≤ 3	0.072	8.30	12.25

Note: ** denotes rejection of the hypothesis at the 5% significance level.

The test of long-run weak exogeneity of each series in the model examines the absence of long-run levels of feed-back due to exogeneity (Johansen and Juselius 1992). In other words, a weakly exogenous variable is a driving variable, which pushes the other variables away from adjusting to long-run equilibrium, but is not influenced by the other variables in the model. The long-run weak exogeneity test is implemented by restricting parameter in speed-of-adjustment (α) to zero in the model. The results show that the U.S. price is weakly exogenous at the 1% significance level (Table 6). This finding suggests that the U.S. price is the driving variables in the system and significantly affects the long-run movements of Canadian prices, but is not influenced by Canadian prices.

Table 6. Weak exogeneity test with sub-sample II (1993:01-2002:04)

Variable	Weak exogeneity $H_0 : \alpha_i = 0$ (LR test static)
US_t	5.57 [0.12]
BC_t	11.42 [0.00]***
QE_t	12.01 [0.00]***
ON_t	10.96 [0.02]**

Note: LR test statistic is based on the χ^2 distribution and parentheses are p-values; *** and ** denote the rejection of weak exogeneity at the 1% and 5% levels, respectively.

It is now necessary to consider whether cointegration vectors are identified, and thus whether they tell us anything about the structural economic relationships underlying the long-run model (Johansen and Juselius 1994). For this purpose, we impose restrictions on the cointegrating spaces, β (Table 7). The likelihood ratio (LR) statistic is 1.38 (p-value = 0.71), indicating that the restrictions are acceptable. The results show that significant coefficients on three Canadian prices in α_1, α_2 and α_3 confirm three cointegration relationships. This finding suggests that joint deviations by the three prices from the steady-state position due to a specific shock in the North American lumber market gradually disappear, and they eventually return to an equilibrium position. On the other hand, the U.S. price is not significant in all of the three relations, indicating that this price do not adjust in the long-run, and thus weakly exogenous.

Finally, the long-run coefficients (β) explain the cointegrating relationships among the price series (Table 7). For example, the first error-correction model, $EC1(\beta_1)$, which represents the BC price relation, is written as follows:

$$(10) \qquad EC1: BC_t = 0.47ON_t + US_t + 0.001trend$$

Equation (10) shows that, in the long-run, the law of one price (LOP) holds between the U.S. and BC. In addition, the BC price increases as the Ontario price rises. The short-run adjustment within $EC1$ occurs primarily through the BC and Ontario prices. The second and third error-correction models also show that the LOP holds among the U.S., Quebec, and Ontario prices.

Table 7. Tests for the restrictions on cointegration vectors in U.S. and Canadian lumber price model with sub-sample II (1993:01-2002:04)

	Eigenvectors			Weights		
	β_1	β_2	β_3	α_1	α_2	α_3
BC_t	1.00	0.00	-0.32** (0.07)	-0.48** (0.17)	-0.17** (0.06)	-0.30** (0.12)
QE_t	0.00	1.00	0.00	-0.30** (0.13)	-0.16** (0.06)	-0.21* (-0.11)
ON_t	-0.47** (0.07)	0.00	1.00	-0.32** (0.15)	-0.11** (0.05)	-0.43** (0.18)
US_t	-1.00	-1.00	-1.00	0.18 (0.19)	0.09 (0.13)	0.19 (0.17)
Trend	-0.001** (0.0002)	0.00	0.00	-	-	-

Note: ** denotes significance at the 5% level. Parentheses are standard errors; LR test statistic is $\chi^2(3)$=1.38, p-value=0.71.

VEC Model

The VEC model is estimated to find the short-run adjustment to long-run steady states as well as the short-run dynamics among price series. For this purpose, with the identified cointegration relationships, the VEC model in equation (9) is estimated. The methodology used to find this representation follows a general-to-specific procedure (Hendry 1995). Specifically, since the U.S. price is found to be weakly exogenous to the system, the VEC model is first estimated conditional on the U.S. price. By eliminating all the insignificant variables based on an F-test, the parsimonious VEC (PVEC) model is then estimated using full-information maximum likelihood (FIML, Harris and Sollis 2003). The number of lags included in the PVEC model is the same as in the cointegration test. The multivariate diagnostic tests on the estimated model as a system indicate no serious problems with serial correlation, heteroskedasticity, and normality (Table 8). Hence, the model specification does not violate any of the standard assumptions.

Table 8. Parsimonious VEC model with sub-sample II (1993:01-2002:04)

	ΔBC_t	ΔQE_t	ΔON_t
ΔBC_{t-1}		0.28 (3.99)***	
ΔBC_{t-3}		0.19 (2.22)***	
ΔQE_{t-1}	0.21 (3.70)***		0.19 (3.28)***
ΔQE_{t-3}	0.57 (3.07)***	0.66 (3.09)***	0.60 (3.00)***
ΔQE_{t-4}	-0.21 (-2.12)**	-0.17 (-1.93)*	
ΔON_{t-3}	-0.67 (-3.30)***	-0.89 (-3.86)***	-0.68 (-3.15)***
ΔON_{t-4}	0.21 (1.98)**	0.20 (2.01)**	
ΔUS_{t-2}	0.44 (2.49)**	0.50 (2.53)**	0.57 (3.01)***
$EC1$			-0.09 (-1.69)*
$EC2$	-0.08 (-3.34)***	-0.05 (-2.30)**	
$EC3$	-0.24 (-2.48)**	-0.43 (-3.96)***	-0.32 (-3.14)***
Constant	0.63 (4.08)***	0.55 (3.80)***	0.38 (2.74)***
Multivariate Tests	$F_{AR}(63,221) = 0.68$ [0.96]; $F_{ARCH}(228,323) = 0.90$ [0.81]; $\chi^2(6) = 4.03$ [0.13]		

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively; EC1, EC2, and EC 3 represent error-correction terms. Parentheses in multivariate tests are p-values.

The results of the PVEC models show that the error-correction terms for BC, Quebec, and Ontario prices are negatively significant at the 10% or better significance level (Table 8). The negative coefficient of the error-correction term ensures that the long-run equilibrium can be achieved. The absolute value of the error-correction term indicates the speed of adjustment to equilibrium. The results thus indicate that when deviating from equilibrium conditions, BC, Quebec, and Ontario prices adjust to correct long-run disequilibria in the North American lumber market. However, the adjustment toward equilibrium is not instantaneous. For example, BC price adjusts by 8% and 24% to the respective long-run equilibria (EC2 and EC3) in one month. These results imply that it takes more than 12 months (1/0.08 = 12.5 months) and more than four months (1/0.24 = 4.2 months), respectively, to eliminate the disequilibria. It should be noted that the Softwood Lumber Agreement (SLA) during 1996-2001 may result in changes in U.S. and Canadian lumber prices. To capture such an effect, therefore, the dummy variable is included in the assessments. However, due to insignificant coefficients, the dummy for the SLA is dropped in the PVEC model. This indicates that the SLA had little impact on U.S. and Canadian lumber prices.

Finally, the coefficients of the lagged variables in the PVEC models show that the short-run dynamics or causal linkage between U.S. and Canadian lumber prices. Two period lagged U.S. price is statistically significant and positively correlated with BC, Quebec, and Ontario prices; for example, a 1% increase in the U.S. price causes a 0.44-0.57% increase in Canadian prices. The result thus indicates that the U.S. price has a significant short-run dynamic effect on the Canadian prices over the last decade.

Summary and Conclusions

This paper first examines structural changes in the U.S., British Columbia, Quebec, and Ontario lumber prices and then determines the dynamics of price relationships among them. We utilize Perron's (1989) test to achieve the first objective and the Johansen cointegration analysis and VEC model to determine both short-run and long-run price relationships.

The results of unit root tests under structural change provide statistical evidence that the price instability witnessed in 1992 has caused structural shifts for the U.S. and Canadian lumber prices. The structural shift coincides with the period over which restrictions on federal timber harvests in the PNW implemented. This finding further suggests that, when estimating behavior relationships with historical data, it is important to test for unit roots allowing for major policy shocks as structural shifts.

The results of the cointegration analysis show that the whole softwood lumber market in North America, including both the U.S. and three Canadian provinces, is indeed integrated. The U.S. price is consistently found to be weakly exogenous in the North American lumber market, implying that it influences the model to drift away from the long-run steady state position, but is not affected by other variables. The results of the VEC model indicate that the short-run dynamics are characterized by unidirectional causation, with the U.S. price significantly affects the Canadian prices.

Therefore, we conclude that the U.S. price significantly affects Canadian prices in both short-run and long-run in the integrated North American lumber market. In other words, the U.S. acts as the price leader and the Canada as the follower in the North American lumber market. Furthermore, the discovery of U.S. price leadership indicates that the Canadian prices respond to the U.S. price change but U.S. does not respond to Canadian price changes. Hence, this finding may not support the claim of U.S. producers that subsidized Canadian lumber has depressed the U.S. price and harmed the U.S. lumber industry.

References

Doornik, J., and Hendry, D. 1994. Interactive econometric modeling of dynamic system (PcFiml 8.0). International Thomson Publishing, London, UK.

Doornik, J., and Hendry, D. 2001. Empirical econometric modeling (PcGive 10). Timberlake Consultants Ltd, London.

Elliott, G., Rothenberg, T.J., and Stock, J.H. 1996. Efficient tests for an autoregressive unit root. Econometrica 64: 813-836.

Engle, R., and Granger, C.W.J. 1987. Cointegration and error-correction: representation, estimation and testing. Econometrica 55: 251-276.

Harris, R., and Sollis, R. 2003. Applied time series modeling and forecasting. John Wiley and Sons. Chichester. W. Sussex.

Hendry, D. 1995. Dynamic econometrics. Oxford University Press, London, UK.

Hwang, J., and Schmidt, P. 1996. Alternative methods of detrending and the power of unit root tests. Journal of Econometrics 71: 227-248.

Johansen, S. 1995. Likelihood-based inference in co-integrated vector auto-regressive models. Oxford University Press, London, UK.

Johansen, S., and Juselius, K. 1990. Maximum likelihood estimation and inference on co-integration — with application to the demand for money. Oxford Bulletin of Economics and Statistics 52: 169-210.

Johansen, S., and Juselius, K. 1992. Testing structural hypotheses in a multivariate cointegration analysis of the PPP and the UIP for UK. Journal of Econometrics 53: 211-244.

Johansen, S., and Juselius, K. 1994. Identification of the long-run and the short-run structure: an application to the ISLM model. Journal of Econometrics 63:7-36.

Jung, C., and Doroodian, K. 1994. The law of one price for U.S. softwood lumber: a multivariate co-integration test. Forest Science 40(4): 595-600.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., and Shin, Y. 1992. Testing the null of stationarity against the alternative of a unit root. Journal of Econometrics 54: 159-178.

Maddala, G.S., and Kim, I.M. 1998. Unit roots, co-integration, and structural change. Cambridge University Press, Cambridge, UK.

Nanang, D.M. 2000. A multivariate cointegration test of the law of one price for Canadian softwood lumber markets. Forest Policy and Economics 1(2000): 347-355.

Ng, S., and Perron, P. 2001. Lag length selection and the construction of unit root test with good size and power. Econometrica 69: 1519-1554.

Oehmke, J.F., and Schimmelpfennig, D.E. 2004. Quantifying structural change in U.S. agriculture: the case of research and productivity. Journal of Productivity Analysis 21: 279-315.

Perron, P. 1989. The great crash, the oil shock and the unit root hypothesis. Econometrica 57: 1361-1402.

Uri, N.D., and Boyd, R. 1990. Considerations on modeling the market for softwood lumber in the United States. Forest Science 36(3): 680-692.

Wooldridge, J.M. 2000. Introductory econometrics: a modern approach. Mason, Ohio. South-Western College Publishing.

Yin, R., and Baek, J. 2005. Is there a single national lumber market in the United States? Forest Science 51(2): 155-164.

Zivot, E., and Andrews, D.W.K. 1992. Further evidence on the great crash, the oil-price shock, and the unit root hypothesis. Journal of Business and Economics Statistics 10(3): 251-270.

Productivity in the Sawmilling Industries of the United States and Canada: A Nonparametric Analysis

Yanshu Li, Daowei Zhang, and Rao V. Nagubadi*

* Respectively, Graduate Research Assistant, Professor and Post-doctoral Fellow, School of Forestry and Wildlife Sciences, Auburn University, AL 36849. Yanshu Li can be reached at (334) 844-8058 or Liyans1@auburn.edu.

Productivity in the Sawmilling Industries of the United States and Canada: A Nonparametric Analysis

ABSTRACT.

We use the nonparametric programming approach to estimate technical efficiency and total factor productivity (TFP) growth of sawmill industries in the U.S. and Canada between 1963 and 2001. The results show that Canadian sawmill industry is more efficient than the U.S. counterpart during the whole study period. The weighted annual productivity growth of sawmill industry is 2.5% for the U.S. and 1.3% for Canada. Regional differences in technical efficiency and TFP growth exist. All regions are shown to have a trend of moving towards the industry frontier.
Key Words: Nonparametric programming approach, Malmquist productivity index, sawmill industry

Introduction

Productivity measures the efficiency with which inputs are transformed into outputs. Higher productivity occurs when larger quantities of outputs are produced with given amount of inputs. Among various techniques to estimate the performance of industries, total factor productivity (TFP) provides a simple yet comprehensive measurement. TFP, the ratio of an index of aggregate output to an index of aggregate input, is a measure taking into account the contribution of all inputs.

Productivity comparisons in the North American sawmilling industries have been of concern for decades as they play an important role in regional resource allocation and relative competitiveness among regional counterparts. Although costs of inputs affect relative competitiveness in the short run, competitiveness in the long run will be determined by technical efficiency and productivity growth. While many studies have been devoted to the productivity growth of the sawmill industry in the U.S and Canada, the results are mixed. Some studies suggest that there has been little or no technical progress in Canada, and productivity growth in the Canadian sawmill industry is lower than the U.S. counterpart (Ghebremichael et al. 1990, Abt et al. 1994, Nagubadi and Zhang 2004). At one extreme, Meil and Nautiyal (1988) reported negative TFP growth for all four Canadian regions over 1950-1983. On the other hand, Gu and Ho (2000) estimated that TFP growth of lumber & wood products industry increased by 0.62% per year in Canada while decreasing by 0.21% annually in the U.S. between 1961 and 1995.

Different approaches adopted by these studies may contribute to the differences in the results. Often, either an index approach or an econometric model is used to estimate productivity growth and technical change. Both approaches assume that all firms in the industries operate efficiently, which may not be the case in the reality, and some specific forms of cost or profit functions have to be assumed in the first place for econometric analysis.

As a more flexible approach, a nonparametric programming approach has been used extensively recently in the area of agricultural and industrial productivity analysis (e.g., Granderson and Linvill 1997, Preckel et al. 1997, Arnade 1998, Yin 2000, Hailu and Veeman 2001, Nin et al. 2003). This method, proposed by Färe et al. (1994) involves estimating an input or output based Malmquist index. Compared to other methods, the nonparametric programming approach has the advantage of imposing no *a priori* restrictions on the functional form of the underlying technology and allowing for inefficiency in production (Varian 1984). This approach also has the attribute of being capable of decomposing productivity growth into two parts: changes in technical efficiency over time, and shifts in technology over time. Until recently, however, the nonparametric programming approach has rarely been used in sawmill productivity analysis. Nyrud and Baardsen's (2003) analysis of Norwegian sawmill productivity is one of the few exceptions.

This study attempts to expand the analytic scope of the technical efficiency and productivity trends of sawmill industries in the North America by using the nonparametric programming approach. In doing so, answers to the following questions can be obtained: Which state/province, region or country is on average the most efficient in sawmill production in the North America? What is the pattern of TFP growth for each state/province, region or country? Decomposition of productivity growth can also shed a light on the sources of the growth (shift in production frontier, or movement towards or away from the production frontier), which assists policy makers and managers make decisions. The next section reviews distance function and the nonparametric Malmquist index used in this study. Section III describes the data. Section IV presents the results. Section V concludes and provides suggestions for future research.

Methodology: Distance Function and the Malmquist Productivity Indices

As in Caves et al. (1982), the productivity change of the sawmilling industry over time is estimated as the geometric mean of two output-based Malmquist productivity indices, which are developed based on distance functions. Suppose that for each time period $t = 1,...,T$, the feasible production set of the industry is:

$$S^t = \{(\mathbf{x}^t, \mathbf{y}^t): \mathbf{x}^t \text{ can produce } \mathbf{y}^t\} \quad [1]$$

Where, $\mathbf{x}^t \in \mathbb{R}_+^N$ and $\mathbf{y}^t \in \mathbb{R}_+^M$ are input and output quantity vectors from N and M dimensional real number spaces, respectively. S^t is assumed to be closed, bounded, convex and to satisfy strong disposability[1] of outputs and inputs.

Following Shepherd (1970), the output-based distance function at t is defined as the reciprocal of the maximum proportional expansion of output vector $\mathbf{y}^t$ given input $\mathbf{x}^t$:

$$D_0^t(\mathbf{x}^t, \mathbf{y}^t) = \inf\left\{\theta : (\mathbf{x}^t, \frac{\mathbf{y}^t}{\theta}) \in S^t\right\} = (\sup\{\theta : (\mathbf{x}^t, \theta\mathbf{y}^t) \in S^t\})^{-1}. \quad [2]$$

The distance function measures how far the production function being interested is from the frontier of the whole industry in period t. Figure 1 shows the case of two outputs (y_1 and y_2), the frontier at *t* is developed by production unit *B*, *C*, and *D*. For production unit *A*, the distance function at *t* can be expressed as $D_0^t(\mathbf{x}^t, \mathbf{y}^t) = \frac{OA^t}{OP^t}$. And its distance function in *t*+1 is $\frac{OA^{t+1}}{OP^{t+1}}$. $D_0^t(\mathbf{x}^t, \mathbf{y}^t)$ is equal to 1 when production unit is on the frontier, or technically efficient. Accordingly, $D_0^t(\mathbf{x}^t, \mathbf{y}^t)$ is less than 1 when production is technically inefficient. The greater it is, the closer is the production unit to the efficient frontier. The distance function provides a complete characterization of the production technology.

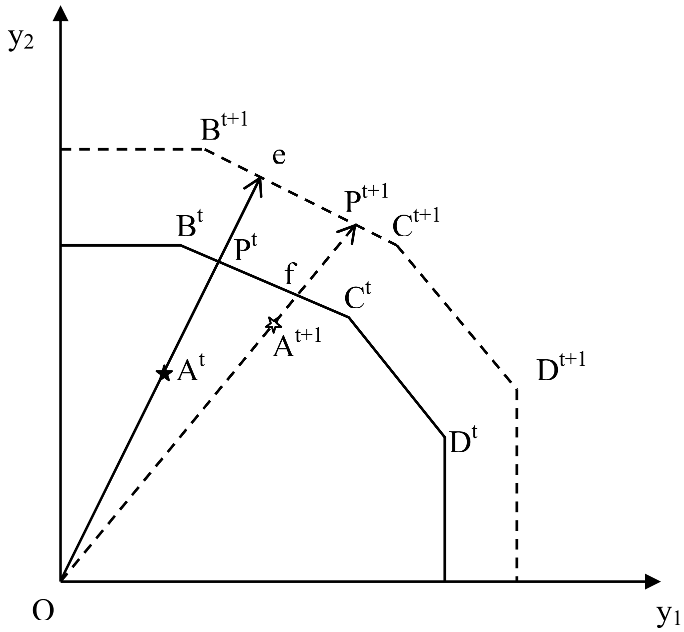


Figure 1. Output Distance Functions in Two Periods (two outputs)

$D_0^t(\mathbf{x}^t, \mathbf{y}^t)$ can be obtained by solving the following linear programming model:

$$\underset{\lambda_k, \theta_{k^*}}{Maximize}\ (D_0^t(\mathbf{x}^t, \mathbf{y}^t))^{-1} = \theta_{k^*}^t$$

Subject to:

$$\sum_{k=1}^{K} \lambda_k y_{km}^t \geq y_{k^*m}^t \theta_{k^*}^t \qquad m=1,\ldots,M$$

$$\sum_{k=1}^{K} \lambda_k x_{kn}^t \leq x_{k^*n}^t \qquad n=1,\ldots,N \qquad [3]$$

$$\lambda_k \geq 0 \qquad k=1,\ldots,K$$

where, *m* indexes outputs; *n* indexes inputs; *k* indexes production regions (k' is a particular region being interested); λ_k is the weight on the kth region data; $\theta_{k^*}^t$ is the efficiency index, or the reciprocal of the distance function for region k'. The inequalities for inputs and outputs make free disposability possible. Non-negativity of λ_k allows the model to exhibit constant returns to scale.

In the same way, the distance from the production point in t relative to the frontier in t+1 can be defined as $D_0^{t+1}(\mathbf{x}^t, \mathbf{y}^t)$ ($\frac{OA^t}{Oe}$ in Fig. 1). Based on Caves et al. (1982), Färe et al. (1994) suggest the use a Malmquist index (M_0) to indicate productivity growth. That is:

$$M_0 = \left[\frac{D_0^t(\mathbf{x}^{t+1},\mathbf{y}^{t+1})}{D_0^t(\mathbf{x}^t,\mathbf{y}^t)} \times \frac{D_0^{t+1}(\mathbf{x}^{t+1},\mathbf{y}^{t+1})}{D_0^{t+1}(\mathbf{x}^t,\mathbf{y}^t)} \right]^{\frac{1}{2}} \quad [6]$$

Improvement in productivity yields the Färe Malmquist index greater than 1 while deterioration in performance over time is associated with the index less than 1. Furthermore, M_0 is shown to be decomposed into an efficiency change component and a technical change component. Equation [6] is equivalent to:

$$M_0 = \frac{D_0^{t+1}(\mathbf{x}^{t+1},\mathbf{y}^{t+1})}{D_0^t(\mathbf{x}^t,\mathbf{y}^t)} \times \left[\frac{D_0^t(\mathbf{x}^{t+1},\mathbf{y}^{t+1})}{D_0^{t+1}(\mathbf{x}^{t+1},\mathbf{y}^{t+1})} \times \frac{D_0^t(\mathbf{x}^t,\mathbf{y}^t)}{D_0^{t+1}(\mathbf{x}^t,\mathbf{y}^t)} \right]^{\frac{1}{2}} \quad [7]$$

where, the first part on the right hand side is defined as efficiency change (*EFFCH*) or “catch up”, which measures the change in how far the observed production unit is from the potential production frontier between period t and period t+1. The second part is defined as technical change (*TECH*) or “innovation”, which captures the shift in technology between two periods. In Figure 1, *EFFCH* is $\frac{OA^{t+1}}{OP^{t+1}} \Big/ \frac{OA^t}{OP^t}$, and TECH is $\frac{OP^{t+1}}{Of} \Big/ \frac{Oe}{OP^t}$ for *A*.

Data

A time-series dataset of sawmills and planing mills[2] covering 1963-2001 for 26 states in the U.S.[3] and 8 provinces in Canada[4] was used. In 2001, selected states accounted for 96.8% of softwood lumber production and 93.2% of hardwood lumber production in the U.S. And selected Canadian provinces accounted for about 99% of both national softwood and hardwood lumber production. Since state-level lumber production data prior to 1963 are not available, the study period was selected from 1963-2001. For purpose of regional comparison, selected states of the U.S. were classified into three regions (West, South and North). Canadian provinces were classified into British Columbia, Ontario, Quebec and Others mainly based on their shares of lumber production.

Main data sources for the U.S are the Annual Survey of Manufactures (ASM) and the Census of Manufacturing (CM). Data for Canada are from the Annual Census of Manufactures (ACM), principal statistics from the Canadian Forest Service, and the CANSIM II database. In 1997, the new industry classification system, North American Classification System (NAICS), was introduced and replaced the Standard Industrial Classification (SIC) system. For this study, we used the industry definition based on the 1987 SIC system. A bridge between SIC and NAICS was constructed based on value of shipments, number of employees, and annual payrolls in 1997. All principal production data[5] in NAICS were converted based on Table 1.

Table 1. Concordance between SIC242 and NAICS for the U.S. used in this study

NAICS	Value of Shipment (%)	# of Employee (%)	Annual Payroll (%)
3211	85	91	91
3219	19	16	15

Five inputs and three outputs were used to estimate the Malmquist index. The construction of each variable is described as follows.

Labor Inputs

Manufacturing-related labor is measured in terms of hours worked for the American states and in terms of hours-paid for the Canadian provinces, which includes paid vacation. Labor not related to manufacturing is measured in terms of the number of employees who are not production workers.

Capital Input

Capital stock in 1997 constant U.S. dollars was estimated by using the perpetual inventory method (PIM). As in Ahn and Abt (2003), investment on plants and structures was depreciated over 28 years, and machinery and equipment was depreciated over 16 years. Annual capital stock estimates for different asset types were aggregated as a total capital stock for each state/province. Following BLS (1983), we chose decay parameter of 0.5 for equipment, and 0.75 for structure.

The U.S. We retrieved the end of year investment data on different assets by state from CM and ASM to year 1954. We estimated the investment data of SIC 242 prior to 1954 by using estimates of national non-residential fixed assets by types from Bureau of Economic Analysis for SIC 24, the average proportion of capital investment of SIC 242 in SIC 24, and each state's average share in total national capital investment in SIC 242 during 1954-1957.

Canada. Annual capital and repair expenditure data are available for three provinces (QC, ON, and BC) during 1970-2001. Other provinces' investment during the same period were estimated by national sawmill industry flows and stocks of fixed non-residential capital, and each province's average share of national industry added value. For all provinces, capital investment data for 1935-1969 were constructed by multiplying national industry fixed capital flows and each province's average share of national industry added value from 1961 to 2001.

Energy Input

The U.S. Since energy quantity data are not available, approximations were made by using energy cost and a weighted aggregate energy price index. Cost of energy includes purchased fuels and electricity assembled from ASM, CM, and the U.S. Census Bureau's publication, "Fuels and electric Energy Consumed".

Canada. Quantities of purchased fuels and electricity are from Catalogues 35-204, 35-250, and Catalogue 57-208 for years 1963-1984. For years 1985-2001, provincial industry energy cost is available from the Canadian Forest Service.

Wood Input

The U.S. Quantities of wood inputs were derived by non-energy material costs and the weighted price of delivered hardwood and softwood sawtimber. Softwood and hardwood sawtimber prices by states for the South over 1977-2001 were collected from Timber Mart South. Southern region average prices were used to estimate prices for the states in the West and the North. The sum of southern-pine sawlog selling price by Louisiana private owners and logging and haul cost was used to estimate industry delivered softwood log price for 1963-1976[6] (Ulrich 1988). The sum of oak sawlog selling price by Louisiana private owners and logging and haul cost was used to estimate industry delivered hardwood log price for 1963-1976. Softwood and hardwood delivered sawtimber prices were aggregated by using state softwood and hardwood production as weights to estimate the weighted price index of wood input.

Canada. Quantities of wood materials were collected from Statistics Canada, Catalogues 35-204, 35-250, and Catalogue 57-208, for the years 1963 to1984. Softwood and hardwood sawtimber were treated as homogeneous, and aggregated by volume in terms of thousand board feet, Scribner. For years thereafter, the quantities were estimated by provincial industry materials cost and a price index. The price index was based on the price data of 1963-1984 and extended to the following years by using industry raw materials price index from Statistics Canada, CANSIM, table 330-0006 and Catalogue no. 62-011-XPB.
http://www.statcan.ca/english/IPS/Data/.htm

Softwood and Hardwood Lumber Outputs

For the U.S., softwood and hardwood lumber production for each state was collected from lumber production and the mill stock section of current industrial reports by the census annually. For Canada, production data from 1963-1984 were collected from Canadian Forestry Statistics. Missing data were interpolated by using the average growth rate of state/province production in the previous 5 years.

Woodchips

The U.S. The quantity of woodchips was estimated based on annual value of shipments and average chip price. Annual state level value of shipment data for woodchips were constructed by the product of industry value of shipments and the share of woodchips in total value of shipments at the national level. Chip price was approximated by the average value of softwood chips exported from four customs districts provided by the Pacific Northwest Research Station.[7]

Canada. The quantity of woodchips for five provinces (NS, NB, QC, ON and BC) over 1963-1980 is available from Canadian Forestry Statistics. Missing data for each province were estimated by annual national woodchips quantity, and annual proportion of woodchips in the industry value of shipments for total products.

Results and Discussions

Outputs or inputs from different states/provinces under the same category were assumed to be homogeneous. Also, each state/province was treated as a production unit as a whole. Technology is assumed to be constant return to scale for the Malmquist index estimation and further decompositions.

Technical Efficiency

Over the 39 years, some states/provinces stayed on the frontier more often than others, especially for BC, SK in Canada and ID, MT, OR, and WV in the U.S. (80% or more of time). Among them, Oregon was the only state which remained on the frontier during the whole period. However, other states/provinces such as NS, AR, NC, TN, and TX were on the frontier for less than 20% of time. Interestingly, they are all southern states. Among them, North Carolina was the only state which had been on the frontier less than 5% of the whole study period.

There are some apparent geographic patterns of distribution of efficient units. The weighted arithmetic means (WAM[8]) of the percentage of time for each region and country on the industry frontier were calculated. Compared to the U.S., the Canadian sawmill industry was more likely to be efficient. During 1963-2001, Canadian sawmills stayed on the industry frontier 74% of time while American sawmills stayed on the frontier 56% of time. Over the whole study period, the U.S. West (81% of the time) and the North (47%) were more likely to be on the frontier than the U.S. South (30%).

It should be noted that the technical efficiency performance for the selected states/provinces varied with different periods of time. Some states/provinces performed efficiently during most of time during the early periods but the performance gradually deteriorated in the later periods, such as BC, MB, NB in Canada, and GA, MI, PA, WI in the U.S. Some other states/provinces were off the efficiency frontier most of time in the early periods but the performance gradually improved in the later periods, such as AB and ON in Canada, and AL, FL, IN, LA, ME, MS, TX, WA in the U.S., most of which are in the U.S. South. In the latest ten years, Canadian province AB as well as American states FL, ID, ME, MT, OR, and WV formed the "best practice" frontier. Although most other western states remained on the frontier, CA apparently moved off from the frontier after the late 1980s.

For most Canadian provinces, the 1980s was a period with the highest rate of technical efficiency. However, on the other hand, the 1990s was a period during which most of Canadian provinces moved off the industry frontier, especially for BC and Quebec, the largest two softwood production provinces in Canada. Meanwhile, more and more the U.S. southern states moved towards and stayed on the efficient production frontier, especially in the latest 10 years.

It should be noted that being more efficient does not imply higher well-being. It only means that states/provinces with higher efficiency scores have exploited their resources relatively better than others in the sample with similar proportional combinations of inputs.

Färe Malmquist Productivity Index and Components

Table 2 provides a summary of the Färe productivity growth index and its decomposition into efficiency and technological change for 1964-2001.

Table 2. Färe Productivity Index, Efficiency Change, and Technical Change for 1964-2001

Province/State	Färe Index (M_0)	Efficiency Change (EFFCH)	Technical Change (TECH)
Canada:	1.013	1.001	1.012
British Columbia	1.014	1.001	1.012
Ontario	1.016	1.002	1.016
Quebec	0.996	1.001	0.999
Others	1.028	1.004	1.025
Alberta	1.051	1.001	1.048
Manitoba	1.004	0.990	1.009
New Brunswick	1.009	0.999	1.009
Nova Scotia	1.013	1.022	1.005
Saskatchewan	1.024	1.002	1.020
United States:	1.025	1.001	1.024
North	1.026	1.000	1.027
Indiana	1.009	0.988	1.018
Maine	1.037	1.011	1.027
Michigan	0.996	1.000	0.998
Missouri	1.024	1.002	1.021
New York	1.055	1.007	1.040
Ohio	1.051	0.993	1.061
Pennsylvania	1.008	0.997	1.013
Wisconsin	1.006	0.994	1.022
West Virginia	1.043	1.004	1.041
South	1.025	1.002	1.022
Alabama	1.026	1.004	1.020
Arkansas	1.035	1.004	1.028
Florida	1.034	1.003	1.030
Georgia	1.009	0.999	1.010
Kentucky	1.050	1.002	1.043
Louisiana	1.027	1.003	1.021
Mississippi	1.021	1.002	1.021
North Carolina	1.032	1.003	1.028
South Carolina	1.029	1.003	1.026
Tennessee	1.040	1.003	1.034
Texas	1.003	0.999	1.006
Virginia	1.021	1.002	1.020
West	1.025	0.999	1.025
California	1.021	0.995	1.028
Idaho	1.023	1.000	1.023
Montana	1.025	1.000	1.024
Oregon	1.030	1.000	1.030
Washington	1.019	1.001	1.017

Most of these states/provinces experienced progress in productivity during the period. The weighted arithmetic means[9] were estimated for each region and country. During 1964-2001, the weighted annual productivity growth of sawmill industry for the U.S. was 2.5%, indicating modest progress. During the same period, Canadian sawmill industry was shown to have a lower growth rate of 1.3%. In the U.S., all regions experienced comparable productivity growth (around 2.5% annually). Michigan was the only U.S. state experiencing regress during the whole period. Most Canadian provinces experienced progress over 1964-2001, Quebec being an exception.

All regions were shown to have positive efficiency change, indicating a trend of moving towards the industry frontier. Differences in productivity growth is mainly attributable to the difference in technical change for Canada and the U.S. during the whole study period (1.2% for Canada and 2.4% for the U.S.).

Sawmill productivity growth experienced ups and downs in the subperiods for both countries and all regions. Most regions experienced regress during the 1970s and progress during all other decades. Before the 1980s, Canada possessed a higher rate of growth (or lower rate of regress) than the U.S. However, the U.S. outperformed Canada after the 1980s (annual rate of growth was 5.0% for the U.S. vs. 2.2% for Canada during 1980s, and 3.2% for the U.S. vs. 0.4% for Canada during 1990s). The U.S. South experienced the highest annual growth rate during the 1980s (6.1%), which contributed to the country's growth significantly. Although the North possessed the highest growth rate during 1960s, the growth rate declined during the subsequent periods. As for Canada, Ontario was the only province which experienced productivity progress during all four time periods. On the other hand, Quebec experienced regress during most of the time, except the 1980s.

Figure 2 shows the cumulated Färe index for the U.S. and Canada during the same period using 1963 as the base year. The cumulated index was calculated as sequential multiplicative sums of weighted annual Färe index values. Apparently, the gap in TFP growth between the U.S. and Canada has widened since the 1990s.

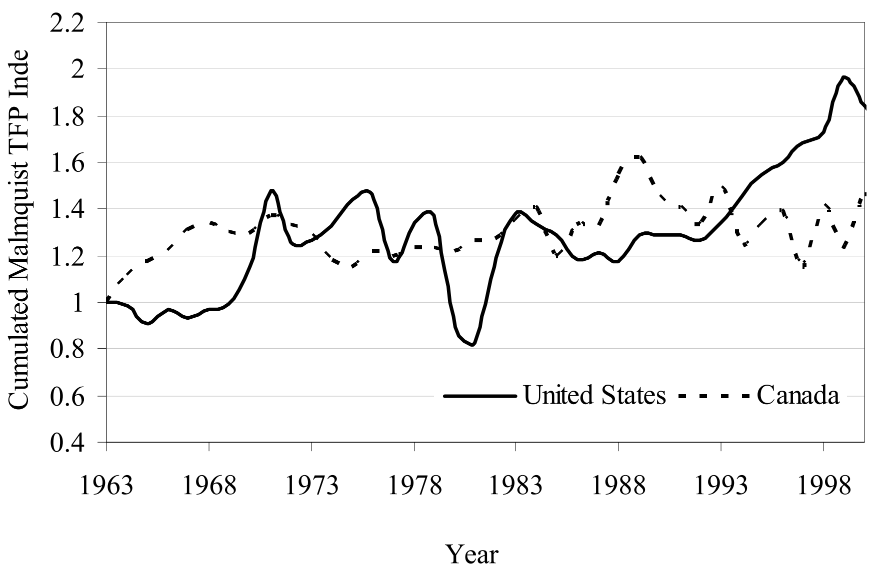


Figure 2. Cumulated Färe productivity indices for the U.S. and Canada, 1963-2001 (Base=1963)

Conclusion

This study used nonparametric programming approach to estimate technical performance and productivity trends of sawmill industries in the North America for the first time. The results showed that the U.S. sawmill industry was more likely to be on the industry frontier than the Canadian counterpart during 1990-2001 although the Canadian sawmill industries were more likely to be efficient than the U.S. counterpart before 1990. This suggested that alleged higher productivity by Canada may not be true for 1990-2001.

During 1964-2001, the weighted annual productivity growth of sawmill industry for the U.S. was 2.5%, indicating progress. During the same period, Canadian sawmill industry was shown to have a lower growth rate of 1.3%. Difference in productivity growth was mainly due to the difference in technical change.

This study suggested that there was a trend of gap-widening between two countries' productivity growth during the late part of the study period. The large difference in annual rate of TFP growth between the U.S. and Canadian sawmilling industries after 1990 led to this widening gap.

It should be noted that this study did not consider the quality difference in inputs and outputs across states and provinces. Meanwhile, there is difference in outputs combinations between the U.S. and Canada. The U.S. has larger proportion of hardwood in total lumber production than Canada. However, the DEA method used in this study did not consider this inherent difference between these two countries as well as among regions.

Endnotes

[1] Which means if $(\mathbf{x}^t,\ \mathbf{y}^t) \in S^t$, then $(\tilde{\mathbf{x}}^t,\ \tilde{\mathbf{y}}^t) \in S^t$ for all $(\tilde{\mathbf{x}}^t,\ \tilde{\mathbf{y}}^t)$ such that $\tilde{\mathbf{x}}^t \geq \mathbf{x}^t$ and $\tilde{\mathbf{y}}^t \geq \mathbf{y}^t$.

[2] 1987 Standard Industry Classification (SIC) System 242 for U.S. and 251 for Canada, concordances between SIC and NAICS are made to assemble the data after 1996.

[3] Selected U.S. western states: California (CA), Idaho (ID), Montana (MT), Oregon (OR), Washington (WA). Selected U.S. northern states: Indiana (IN), Maine (ME), Michigan (MI), Missouri (MO), New York (NY), Ohio (OH), Pennsylvania (PA), Wisconsin (WI), West Virginia (WV). Selected U.S. southern states: Alabama (AL), Arkansas (AR), Florida (FL), Georgia (GA), Kentucky (KY), Louisiana (LA), Mississippi (MS), North Carolina (NC), South Carolina (SC), Tennessee (TN), Texas (TX), Virginia (VA).

[4] Alberta (AB), British Columbia (BC), Manitoba (MB), New Brunswick (NB), Nova Scotia (NS), Ontario (ON), Quebec (QC) and Saskatchewan (SK).

[5] Employee number, production hours and production worker number are converted based on the concordance of # of employee. Employee wages and production worker wages are converted based on the concordance of annual payroll. All others are converted based on the concordance of value of shipment.

[6] Average prices for sawlog sold by private owners in Louisiana, and logging and haul cost were from Ulrich (1988). The original price was in dollars per MBF, Doyle log scale. The conversion factor of 1 Scribner log scale = 1.39 Doyle log scale was used to convert the prices in Doyle log rule to prices in Scribner log rule.

[7] The Seattle, Columbia-Snake, San Francisco, and Anchorage.

[8] Since each state/province has different share in lumber production, weighted average is a better estimate for regional and national estimate than simple average.

[9] Since each state/province has different share in lumber production, weighted average is a better estimate for regional and national productivity growth than simple average. See Färe and Zelenyuk (2003) for detailed discussion on this point. Volume of lumber

production (sum of softwood and hardwood) is used as weight. In this study, simple averages reports greater productivity progress for both Canada and the U.S.

Literature

Abt, R.C., J. Brunet, B.C. Murray, and D.G. Roberts. 1994. Productivity growth and price trends in the North American sawmilling industries: An inter-regional comparison. Can. J. For. Res. 24:139-148.

Ahn, S, and R.C. Abt. Total factor productivity measurement with improved index number. Proceedings of the 2003 Southern Forest Economics Workers Meeting. New Orleans, LA.

Arnade, C. 1998. Using a programming approach to measure international agricultural efficiency and productivity. J. Agri. Econ. 49(1):67-84.

Caves, D.W., L.R. Christenesen, and W.E. Diewert. 1982. The economic theory of index numbers and the measurement of input, output and productivity. Econometrica 50(6):1393–1414

Constantino, L.F., and D. Haley. 1989. A comparative analysis of sawmilling productivity on the British Columbia coast and in the U.S. Douglas-fir region: 1957 to 1982. For. Prod. J. 39(4):57-61.

Färe, R., S. Grosskopf, M. Norris, and Z. Zhang. 1994. Productivity growth, technical progress, and efficiency change in industrialized countries. Amer. Econ. Rev. 84(1):66-83.

Färe, R., S., and Zzelenyuk. 2003. On aggregate Farrell efficiency scores. European Journal of Operational Research 146(3):625-620.

Ghebremichael, A., D.G. Roberts, and M.W. Tretheway. 1990. Productivity in the Canadian lumber industry: An inter-regional comparison. Information Report O-X-411. Forestry Canada, Ontario Region, Great Lakes Forestry Centre. Sault Ste. Marie, Ont.

Granderson, G., and C. Linvill. 1997. Nonparametric measurement of productive efficiency in the presence of regulation. European Journal of Operational Research 110:643-657.

Gu, W., and M.S. Ho. 2000. A comparison of industrial productivity growth in Canada and the United States. Amer. Econ. Rev. 90(2):172-175.

Hailu, A., and T.S. Veeman. 2001. Non-parametric productivity analysis with undesirable outputs: an application to the Canadian pulp and paper industry. Amer. J. Agr. Econ. 83(3):605-616.

Meil, J. K., and J. C. Nautiyal. 1988. An intraregional economic analysis of production structure and factor demand in major Canadian softwood lumber producing regions. Can. J. For. Res. 18:1036-1048.

Nagubadi, R.V., and D. Zhang. 2004. Total factor productivity growth in sawmills and wood preservation industry in the U.S. and Canada: A comparative study.

Nin, A., C. Arndt, and P. V. Preckel. 2003. Is agricultural productivity in developing countries really shrinking? New evidence using a modified nonparametric approach. J. Dev. Econ. 937:1-21.

Nyrud, A.Q., and S. Baardsen. 2003. Production efficiency and productivity growth in Norwegian sawmilling. For. Sci. 49(1):89-97.

Preckel, P.V., J. T. Akridge, and M.A. Boland. 1997. Efficiency measures for retail fertilizer dealers. Agribusiness 13(5):497-509.

Shephard, R.W. 1970. Theory of cost and production functions. Princeton, NJ: Princeton University Press.

Ulrich, A.H. 1988. Timber production, trade, consumption, and price statistics 1950-1986. USDA Forest Serv., Washington D.C.

Varian, H.R. 1984. The nonparametric approach to production analysis. Econometrica 52(3):579-598.

Yin, R.S. 2000. Alternative measures of productive efficiency in the global bleached softwood pulp sector. For. Sci. 46:558-569.

Concurrent Session 2A: Survey Studies I

Evaluating Mississippi's Hunting and Fishing Licenses and Fees

by

Marcus K. Measells[1], Stephen C. Grado[2], Changyou Sun[3], and Keith L. Belli[4]

Acknowledgments: Special thanks to the Mississippi Department of Wildlife, Fisheries, and Parks, especially Michael Bolden (Director, Administrative Services), for allowing us to conduct this study. This manuscript is publication No. FO299 of the Forest and Wildlife Research Center, Mississippi State University.

[1] Research Associate I, Mississippi State University, Forest and Wildlife Research Center, College of Forest Resources, Box 9681, Mississippi State, MS 39762, marcm@ext.msstate.edu. (662) 325-3550 (v); (662) 325-8726 (fax).

[2] Professor, Mississippi State University, Forest and Wildlife Research Center, College of Forest Resources, Box 9681, Mississippi State, MS 39762.

[3] Assistant Professor, Mississippi State University, Forest and Wildlife Research Center, College of Forest Resources, Box 9681, Mississippi State, MS 39762.

[4] Professor, Mississippi State University, Forest and Wildlife Research Center, College of Forest Resources, Box 9681, Mississippi State, MS 39762.

Evaluating Mississippi's Hunting and Fishing Licenses and Fees

Abstract

Mississippi provides ample hunting and fishing opportunities. The Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) promotes these activities, in part, by using revenues derived from licenses and fees. However, recent and anticipated budget cuts have led the MDWFP to assess and potentially adjust revenue sources. This study evaluated license fees and determined the potential effects fee changes would have on revenues. Relevant license fees from surrounding states were examined to see if there was a margin for adjustment. License fee adjustments were recommended for few resident licenses. A sensitivity analysis indicated revenue generation based on past sales trends and recommended price changes. Based on average sales, license recommendations could potentially generate $16.3 million. When recommendations are followed, and average sales materialize, 26% of expenses are expected to be covered. If minimum and maximum expected sales materialize, then 23% and 28% of expenses will be covered, respectively. At worst, if sales drop to the minimum and fee recommendations are not followed, expected revenues would be $12.7 million or 20% of total expenditures. Based on actual and projected revenues it appears, despite recent trends of sale increases for some licenses and decreases for others, that recommended adjustments should help cover near-term expenses.

Key words: fishing licenses, hunting licenses, license assessment, Mississippi, natural resource agencies

Introduction

Mississippi, like many other states endowed with abundant natural resources, provides an ample supply of hunting, fishing, recreational, and other related opportunities for both residents and non-residents. The Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) is the agency responsible for management of these activities. The MDWFP promotes these activities, in part, by using revenues from license, access, user, and other fees directed toward enhancing natural areas, wildlife, habitat, wildlife education, law enforcement activities, and recreational opportunities. Due to recent and anticipated future budget cuts, the MDWFP wanted to assess and potentially adjust their license fees. The fiscal situation was compounded by varying sportsman participation rates as well as complicated legislative issues (e.g., budget restrictions).

Historical data provided by the MDWFP revealed that total revenues generate approximately 40% of their budget. It was the agency's intent to maintain or improve upon this coverage in a climate of stagnating revenues from federal and state funding sources. Regardless of the budget situation, all fees set by the MDWFP need to be periodically reevaluated. Beyond inflationary pressures, hunting and fishing license fees should also be adjusted to reflect any change in value derived from using those licenses. Similar fees in surrounding states should be examined and compared. This is particularly important because non-resident sportsmen will travel long distances to pursue hunting and fishing activities. Several studies have examined hunting and fishing license sales in other states (Duda 1998, Sutton et al. 2001, Floyd and Lee 2002, Mehmood et al. 2003) and decreasing angler participation due to demographic change (Murdock et al. 1990, Murdock et al. 1996, Loomis and Ditton 1998). A loss of license and other sales and in-state activity days would affect revenues collected by the MDWFP and would also affect the state economy. Conversely, attractive non-resident licenses and fees would promote travel to the state, enhance overall revenues, and increase participant expenditures within the economy. In 2001, there were 586,000 anglers and 357,000 hunters in Mississippi who spent $211 million and $360 million, respectively (USDI and USDC 2002). A sizeable number of these sportsmen were non-residents.

According to Johnson (1991), entrance and user fees are a means of restoring recreation funding reduced by budget deficits. The problem then becomes one of adjusting licenses and other fees to retain resident hunters and anglers in the state, increase their activity rates, and also attract non-residents to hunting, fishing, recreational, and other related activities. At the same time, a viable revenue base must be maintained. An analysis of this problem needs to consider external events and historical trends such as the recent downward trend in the purchase of certain types of licenses and fees. Driver and Knopf (1976) and Fedler and Ditton (1994) indicated that if fishing license fees were to reflect the full extent of benefits associated with the resource, they would be much higher. However, Nicholson (1985) stated that recreationists would purchase licenses only if they believe the value of the activity was equal to or greater than the license cost. Johnson (1991) also stated the public was willing to pay these fees, and that to successfully charge fees, managers need to show how the fee will benefit the recreation area or resource.

Mehmood et al. (2003) determined that active Alabama hunters were in favor of modest fee increases.

Several factors have been determined to cause the downward trend in license sales. For example, Mehmood et al. (2003) determined that a decline in Alabama hunting license sales could be attributed to competing interests, aging of former hunters, and a decline in society's support for hunting. In a national study, Fedler and Sweezy (1990) determined that each dollar increase in the real price of a resident annual fishing license would result in a 4.7% decrease in sales.

Adjusting the value-side of the license or fee purchase may be both preferable and biologically feasible. As an example, enhancing the value of hunting licenses by manipulating bag limits, season lengths, and season scheduling may have an impact on participation and revenues. Teisl et al. (1999) determined that the best strategy for increasing revenues was to raise or lower prices based on recreationists' price responsiveness. More specifically, Teisl et al. (1999) predicted that raising resident license prices was the best strategy for increasing revenues.

The study's first objective was to evaluate resident and non-resident hunting and fishing license fees implemented by the MDWFP. The second objective was to determine the potential effects of license fee structure changes on near-term revenues to the MDWFP. A third objective was to provide evidence of the potential economic impacts associated with hunting and fishing activities.

Methods

The MDWFP provided current and historical data that included license types, quantities sold, and associated revenues for each license or permit type. Data were provided for most license types for fiscal years 1983 to 2004. Initially, data were arranged by license type and then sorted by quantity sold and total revenue generated. The analyses focused on the top quantity and revenue producers. A brief information search was conducted to identify characteristics and prices of all relevant licenses and fees in surrounding states (i.e., Alabama, Arkansas, Louisiana, and Tennessee) that were similar in nature to Mississippi's. Similar state-to-state licenses and fees were then compared to see if there was a margin for adjustment of either the fee charged or value offered for a specific activity in Mississippi. In general, comparisons were made between Mississippi's fees and adjacent state fees to determine if prices should be increased, decreased, or remain the same. A sensitivity analysis was performed to indicate revenue generation based on past sales trends and recommended price changes. Projected increases or decreases in license and fee sales were based on trends developed from actual quantities sold from fiscal years 1997 to 2004. This was done because, before 1997, several license types were eliminated or combined to form current license types. License fee adjustments were also recommended based on quantities sold and price differentials between purchased items. Revenue projections were examined where quantities sold would remain unchanged from fiscal year 2004 or approach the minimum, maximum, or average quantities sold from fiscal year 1997 to 2004. Estimates on the overall effects on MDWFP revenues were made from proposed changes in the collective fee structure. Finally, an analysis of the economic impact of license and fee purchases was conducted using Impact Analysis for Planning (IMPLAN).

Results

The analysis attempted to gauge revenues that could be obtained by adjusting license prices, while also attempting to determine reasonable trends for future purchases. The average, maximum, and minimum annual changes in resident and non-resident license sales from fiscal years 1997 to 2004 are reported in Tables 1 and 2. Weighted average resident hunting and

Table 1. Average, maximum, and minimum annual changes in Mississippi's resident license sales during fiscal years 1997 to 2004.

Resident license type	**Average change (%)**	**Maximum change (%)**	**Minimum change (%)**
Sportsman	4.80	7.17	1.81
All Game Hunting/Freshwater Fishing	-6.23	-3.65	-9.81
Archery/Primitive Weapon	-14.10	18.81	-29.73
Small Game Hunting/Freshwater Fishing	-5.44	-0.35	-9.45
Freshwater Fishing	0.05	5.43	-4.19
3-Day Freshwater Fishing	3.34	25.44	-16.12
Commercial Fishing	0.28	30.35	-19.76
State Trapper	-1.31	15.87	-19.95
Fur Dealer	4.21	58.33	-39.13
Overall change	**-0.48**	**1.52**	**-3.87**

Table 2. Average, maximum, and minimum annual changes in Mississippi's non-resident license sales during fiscal years 1997 to 2004.

Non-resident license type	**Average change (%)**	**Maximum change (%)**	**Minimum change (%)**
Freshwater Fishing	1.82	15.33	-7.84
1-Day Freshwater Fishing[a]	43.88	43.88	43.88
3-Day Freshwater Fishing	-14.45	6.23	-49.86
All Game Hunting	-0.48	6.62	-19.82
Youth All Game Hunting	3.69	15.86	-5.41
7-Day All Game Hunting	5.90	20.41	-9.43
Youth 7-Day All Game Hunting	10.70	43.11	-8.79
Small Game Hunting	4.91	12.53	-1.12
7-Day Small Game Hunting	2.91	12.96	-5.84
Archery/Primitive Weapon	0.79	11.22	-23.80
3-Day Archery/Primitive Weapon[a]	204.44	204.44	204.44
Shooting Preserve	-1.15	32.78	-47.20
Commercial Fishing	6.96	37.50	-19.23
State Trapper	51.71	171.43	-12.31
Fur Dealer	0.48	100.00	-55.56
Overall change	**0.73**	**1.97**	**-2.65**

[a]Based on data during fiscal years 2003 and 2004.

fishing license average sales during this time period were –0.48% per year, whereas the weighted average annual ranged from –3.87 to 1.52%. Individually, the largest average annual decrease was for the Archery/Primitive Weapon license (-14.10%). The greatest annual average increase was for the Sportsman license (4.80%) which was also the largest resident revenue generator. Non-resident hunting and fishing license sales during this time period had a weighted average average of 0.73% and a weighted average annual range from –2.65 to 1.97%. Individually, the largest annual average decrease was for the 3-Day Freshwater Fishing license (-14.45%). The greatest annual average increase since 1997 was for the State Trapper license (51.71%). In total, all license sales averaged a 0.07% increase, with the annual average ranging from –5.25% to 4.35%. Total resident revenues increased 3.4% in the past 5 years and 6.5% during fiscal years 1997 to 2004 even though number of sales decreased by an annual average of 0.48%. Total non-resident revenue increased 27.3% in the past 5 years and by 43.9% during 1997 to 2004 even though sales only marginally increased by the weighted average annual average of 0.73%.

License fee recommendations were made by considering past changes, sales trends, and by examining similar fees charged in other states. Also taken into consideration was the fee for the Sportsman license relative to its components; the All Game Hunting/Freshwater Fishing license and the Archery/Primitive Weapon license. State Trapper and Fur Dealer licenses were left unchanged because any recommended changes would result in minimal changes in revenues. All recommended price changes were for the resident licenses in Mississippi and are reported in Table 3. Non-resident fees were unchanged because these fees were last increased in 2002.

The sensitivity analysis for resident, non-resident, and miscellaneous license fees was based on changes to 2004 resident license prices and fees and changes in license sales from 2004 and was used to project revenues. For resident licenses, the recommended scenarios of zero, average, minimum, and maximum changes in license sales would lead to revenues of $7.48 million, $7.56 million, $7.28 million, and $7.81 million, respectively. For non-resident licenses, the same scenarios would result in revenues of $7.66 million, $8.04 million, $6.70 million, and $8.78 million, respectively. For miscellaneous licenses, the same scenarios would result in revenues of $0.73 million, $0.74 million, $0.44 million, and $1.09 million, respectively. Table 4 illustrates the total revenues for fiscal year 2006 due to changes in resident license fees and license sale assumptions.

The total annual economic impact of hunting and fishing license purchases to the state of Mississippi ranged from $21.3 to 26.6 million if no changes were made to the fee schedule. However, if the recommended fee changes were implemented, the annual economic impact would range from $24.2 to 29.6 million, an increase of approximately $3 million. These amounts only a reflect revenues generated by license sales and do not account for impacts of all other outdoor recreationists' expenditures in the state.

Table 3. Newly recommended prices for Mississippi's resident license fees for fiscal year 2006 based on past changes, sales trends, and by examining other states' similar fees.

License type	**2004 Fees ($)**	**Recommended changes ($)**	**New license fees ($)**
Sportsman	32	8	40
All Game Hunting/Freshwater Fishing	17	8	25
Archery/Primitive Weapon	14	6	20
Small Game Hunting/Freshwater Fishing	13	3	16
Freshwater Fishing	8	2	10
3-Day Freshwater Fishing	3	3	6
Commercial Fishing	30	20	50
State Trapper	25	0	25
Fur Dealer	50	0	50

Table 4. Hunting and fishing license fee revenue projections for the Mississippi Department of Wildlife, Fisheries, and Parks for fiscal year 2006 based on changes in resident license fees and license sale assumptions.

Resident and non-resident license fee changes	Sales same as 2004	Average expected sales[a]	Minimum expected sales[a]	Maximum expected sales[a]
No change from 2004 fees	$14,097,997	$14,568,170	$12,718,408	$15,840,800
Recommended fee changes from 2004	$15,868,207	$16,339,787	$14,418,978	$17,678,665

[a]Based on changes in license fee sales during fiscal years 1997 to 2004.

Discussion

Revenue and constituent support are both important to the MDWFP. Therefore, the data were analyzed with both in mind. In most cases, directives were based on historical data and trends from for the past eight fiscal years where license types were consistent. More sophisticated analyses were limited by the fact that a key variable, license or fee prices, have rarely changed over this period.

One trend that stood out was that for almost all license and fee categories, total sales, on average, decreased over the 1997 to 2004 period. This downward trend, the fact that resident license fees were last changed in 1994, and that recent price increases in 2002 for non-resident licenses resulted in a small number of price increase recommendations. These price recommendations need to be accepted in total because they were increased to favor the key revenue generator license, the Sportsman license, versus encouraging the purchase of specific hunting or fishing licenses only.

Based on actual and projected revenue requirements for the MDWFP it appeared that, despite recent increases for some license types and decreases for others, price increases recently instituted for non-residents in 2002, recommended license fee adjustments should be sufficient to cover a portion of the agency's near-term expenses ($64 million in 2006). In the worst scenario, if sales were to drop to the minimum expected and resident fee recommendations were not followed, expected revenues would be $12,718,408. In this situation, hunting and fishing license revenues would cover 20% of expenditures. If resident fee recommendations are followed and average expected sales materialize, 26% of expenditures are expected to be covered. If minimum and maximum expected sales materialize, then 23% and 28% of expenditures will be covered, respectively. In addition, the recommendations and projections would still sustain a sizeable direct economic impact to the state from licenses and fees. More importantly, while it is known that licenses and fees are a small portion of sportsman expenditures (USDI and USDC 2002), the economic impacts attributed to the total hunting and fishing experience are much larger. Therefore, licenses and fees need to be reasonable and justified because sportsmen will focus on these identifiable expenses and may be influenced to go elsewhere, resulting in lower overall economic impacts within the state.

Conclusions

A number of recommendations were made from this study. As previously noted, one was to increase certain resident licenses fees to match fees charged by surrounding states. Another recommendation was offered to generate additional revenue. Several states in the southern region are charging a fee or requiring a permit (generally ranging from $10 to $26) for individuals who hunt on state wildlife management areas (WMAs). For example, both Alabama and Louisiana charge $15. Mississippi was the only state in the region that does not charge for using public WMAs. In fiscal year 2004, the MDWFP estimated a total of 167,853 activity days were spent on Mississippi's WMAs. Assuming that the average sportsman spent 8 activity days that year hunting on a WMA, this represented approximately 20,980 individuals who would need to purchase a WMA permit. At a permit cost of $15, this would represent an additional $314,700 in revenue for the MDWFP. It is possible this amount could be larger. If the number of individuals using Mississippi's WMAs and corresponding activity days were known with greater certainty, expected increases in revenues could be estimated with greater accuracy.

There were several other areas requiring further research. First, the MDWFP needs to examine how changes in bag limits and season length may increase revenues by species type. Second, there is a need to survey the constituency to assess their propensity, willingness-to-pay, willingness to purchase certain license fees or permits at various prices, based on value received. Ready et al. (2005) determined that projections based on stated behavior (e.g., in a survey) was better than projections from revealed behavior (e.g., historical license sales) at predicting resident fishing license sales in Pennsylvania. Unfortunately, due to time constraints such a survey could not be accomplished. Administrative fees now attached to the purchase of licenses and other fees could also have been incorporated into the analysis. For the consumer, this is part of the "price" of participating in an activity.

Finally, any change in license fees or permits should be instituted with a marketing strategy to provide information to current and potential sportsmen and recreationists on the benefits derived from individual licenses, fees, and permits as well as the programs that benefit from these revenues. As in recreation studies we previously alluded to, recreationists' objections are minimized, and support often garnered, when participants see the benefits of fees they are being asked to pay.

Literature Cited

Driver, B.L., and R.C. Knopf. 1976. Temporary escape: One product of sport fisheries management. Fisheries 1(2):21-29.

Duda, M. 1998. Factors relating to hunting and fishing participation in the United States. Responsive Management, Harrisonburg, VA.

Fedler, A.J., and R.B. Ditton. 1994. Understanding angler motivations in fisheries management. Fisheries 19(4):6-13.

Fedler, A.J., and N.N. Sweezy. 1990. National license study: A state by state analysis of factors that affect sport fishing license sales. Report prepared for the Division of Federal Aid, U.S. Fish and Wildl. Serv. Sport Fishing Institute, Washington, D.C.

Floyd, M.F., and I. Lee. 2002. Who buys fishing and hunting licenses in Texas? Results from a statewide household survey. Human Dimensions of Wildl. 7(2):91-106.

Johnson, R. 1991. Pay to play: A rationale for user fees. Am. For. 97(3/4):52-54, 72-73.

Loomis, D.K., and R.B. Ditton. 1998. Technique for projecting the future growth and distribution of marine recreational fishing demand. N. Am. J. of Fisheries Manage. 8:259-263.

Mehmood, S., D. Zhang, and J. Armstrong. 2003. Factors associated with declining hunting license sales in Alabama. Human Dimensions of Wildl. 8(4):243-262.

Murdock, S.H., K. Backmon, E. Colberg, M.N. Hoque, and R. Hamm. 1990. Modeling demographic change and characteristics in the analysis of future demand of leisure services. Leisure Sci. 12(12):79-102.

Murdock, S.H., D.K. Loomis, R.B. Ditton, and M.N. Hoque. 1996. The implications of demographic change for recreational fisheries management in the United States. Human Dimensions of Wildl. 1(4):14-37.

Nicholson, W. 1985. Microeconomic Theory: Basic Principles and Extensions. 3rd edition. Dryden Press. Chicago, IL.

Ready, R, D. Epp, and W. Delavan. 2005. A comparison of revealed, stated, and actual behavior in response to a change in fishing quality. Human Dimensions of Wildl. 10(1):39-52.

Sutton, S.G., J.R. Stoll, and R.B. Ditton. 2001. Understanding anglers' willingness to pay increased fishing license fees. Human Dimensions of Wildl. 6(2):115-130.

Teisl, M.F., K.J. Boyle, and R.E. Record, Jr. 1999. License-sales revenues: Understanding angler and hunter reactions to changes in license prices. Human Dimensions of Wildl. 4(4):1-17.

U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau (USDI and USDC). 2002. 2001 National Survey of

Fishing, Hunting, and Wildlife-Associated Recreation, Mississippi. U.S. Gov. Printing Office, Washington, D.C.

Looking for a Win-win Situation:
Meta-Analysis of Deforestation and Poverty

Stibniati S. Atmadja [1]
North Carolina State University

Erin O. Sills
North Carolina State University

Acknowledgments:
This paper is based on Atmadja's masters paper. We would like to thank Dr. John Monahan, of North Carolina State University's Dept of Statistics, for advice on statistical methods, and Dr. Mitch Renkow of the NCSU Dept of Agricultural Economics, for helpful comments.

[1] PhD Candidate, Dept. of Forestry and Environmental Resources. Campus Box 8008, North Carolina State University, Raleigh, NC 27695. ssatmadj@ncsu.edu

Looking for a Win-win Situation:
Meta-Analysis of Deforestation and Poverty

Stibniati S. Atmadja and Erin O. Sills, North Carolina State University

ABSTRACT

The relationship between poverty and deforestation has long been debated. Many international agencies are pursuing policies predicated on the possibility of a 'win-win' outcome in which reducing poverty simultaneously reduces deforestation. In this paper, we examine the empirical literature for evidence on this relationship. We conduct a meta-analysis of 37 studies that estimate regression models of deforestation, examining the sign and statistical significance of the poverty coefficients. Three methods are used: vote-counting, combined tests, and meta-regression, each producing slightly different results. The meta-regression indicates that studies found in non-economic publications are more likely to support the win-win hypothesis. Overall, we conclude that the empirical literature does not support the currently wide-spread assumption that deforestation and poverty go hand-in-hand.

Key Words: vote-counting, meta-regression, poverty-deforestation nexus

I. INTRODUCTION

The sustainable development concept in forest policy is predicated on the existence of 'win-win' strategies that combat deforestation by combating poverty. This has great appeal because it means that economic development, as a vehicle for poverty alleviation, need not be at odds with the environment.

Many researchers have questioned the viability of win-win strategies. Is this concept more of a political convenience than an empirical phenomenon? There is no clear consensus in the scientific literature on the relationship between poverty and deforestation, yet critical policy changes have already been made based on the win-win assumption.

We dig deeper into the literature and investigate if there is an underlying 'rule' or empirical regularity governing the poverty-deforestation relationship. Specifically, we consider empirical studies that use income (or some other measure of poverty) to explain deforestation. Meta-analysis is an appropriate tool to systematically review and extract lessons from this explanding literature.

A recent review of the literature by scientists at CIFOR found that more than half of the studies reporting deforestation models use regression analysis to identify the causes of more than half of the deforestation models use regression analysis[2], making it the most common analytical tool in the deforestation literature. Deforestation can be modeled as:

[2] 77 out of 150 deforestation models use regression analysis (Kaimowitz and Angelsen, 1998, p. 13)

$$\text{deforestation} = \alpha + \beta \text{ poverty} + \vartheta \underline{x} + \varepsilon$$
Equation 1

The nature of poverty-deforestation nexus can be evaluated by testing the hypothesis:

H_0 : $\beta \le 0$ (win-win situation does not prevail)
H_1 : $\beta > 0$ (win-win situation prevails)

Where α = intercept, β = coefficient of poverty, ϑ = coefficient of other explanatory variables (or inverse of coefficient on income), and $\underline{x}$ = matrix of other explanatory variables for deforestation. We focus on the statistical significance of the poverty variable β.

The next section reviews the literature linking poverty and deforestation, economic models of deforestation, the development of meta-analytic methods, and applications of meta-analysis in economics. We proceed to review three methods of meta-analysis used in this paper (vote-counting, combined tests, and meta-regression analysis), followed by a description of the data set and the results. The final section discusses the implication of these results regarding the relationship between poverty and deforestation.

II. LITERATURE REVIEW

Relationship between Poverty and Deforestation

The factors that drive deforestation are still uncertain. Variables used in the past include population density, agriculture and timber prices, environmental and ecological variables, corruption and equality measures, national debt burden, and tenureship. More robust variables are timber and agriculture prices, forest and market accessibility, and wages (Kaimowitz and Angelsen 1998). Poverty, however, has not been as robust (See Wunder 2000, p.34-37).

The link between poverty and deforestation can be characterized by: (i) More poverty leads to more deforestation ($\beta>0$), or (ii) More poverty leads to less deforestation ($\beta < 0$). Alternatively, the relationship can change with time. At early levels of economic development, countries draw heavily upon their natural resources to reach industrial takeoff, reducing environmental quality. It peaks at some intermediate level of development. From this point on, conservation becomes an important component of welfare, leading to an increase in environmental quality. This trend is known as the Environmental Kuznets Curve (EKC).

The EKC has been observed for some pollutants that involves short-term costs (e.g. sulfur, particulates, fecal colliform) (Grossman and Krueger 1995), but not for those that are long-term and geographically more dispersed like CO_2 (Arrow et al. 1995; Holtz-Eakin and Selden 1995; Seldon and Song 1994). Some believe it is less likely found in the poverty deforestation relationship, where feedback effects are significant (Arrow et al. 1995), but others have found this U-shaped relationship between gross domestic/national product per capita and deforestation (Cropper and Griffiths 1994, Rudel 1998, Mather, Needle and Fairbairn 1999).

There is evidence that the win-win situation exists (Deininger and Minten 1999). Many also caution that the relationship between them is complex, and simple generalizations only apply in limited scopes (e.g. Angelsen 1997, Wunder 2001, Zeller et al. 1999, Duraiappah 1998, Wibowo and Byron, 1999). For example, the poverty and deforestation nexus is not only a one-way relationship. The win-win strategy applies to the other direction as well: deforestation cause more poverty, which is less debated in the literature. Interestingly, there was much evidence that the contrary is true: forest land clearing has improved the wellbeing of immigrant households (See Sunderlin and Rodríguez 1996, p.13, Jones 1990, and Rudel 1993 as cited in Wunder 2000, p.36). This was also found in the macroeconomic scale (Reed 1992, pp.154-7). It is difficult to test for this endogeneity effect using our dataset; very few studies that took endogeneity into account (4 out of 39 studies).

Meta-Analysis

Meta-analysis treats individual studies as datapoints, and uses statistical methods to quantitatively summarize these studies. It was developed in response to the flood of research in social science in the 1970s. As the volume of studies increased, it became clear that traditional narrative literature review suffered from "dependence of subjective judgments, preferences, and biases of the reviewers, and from disparate definitions, variables, procedures and samples of original investigators" (Wolf, 1986, p. 5).

Meta-analysis can provide a more objective and systematic synthesis. It is quantitative and uses statistical methods to organize and extract information from large numbers of studies that would otherwise be incomprehensible. There is no prejudgment on research quality; determining the influence of study quality on findings is part of the meta-analysis exercise, instead of being done arbitrarily by the reviewer, resulting in less bias.

The use of meta-analysis in economics started in the 1990s. Meta-regression is the most widely used technique. In forest economics, vote-counting has also been applied (e.g. Pattanayak, et al. 2002, Beach, et al. 2003). Most meta-analyses in economics use 25 to 40 studies, ranging from 9 studies to 400[3].

Kaimowitz and Angelsen (1998), Geist and Lambin (2001), and Rudel et al. (2000) provide comprehensive reviews of the deforestation literature. However, they do not go beyond informal vote-counting and thus do not systematically compare the empirical findings in the vast literature with current policy initiatives. We seek to fill this gap using the methods described in the following section.

[3] A citations list of meta-analysis studies in economics can be obtained from the first author.

IV. METHODS

Data Collection

Studies were conducted in two stages. The first stage is running a conventional keyword search in 3 academic databases (EconLit, CAD Abstracts, and TREECD), internet search engine (Google.com) and the FOCUS 1 case study database on land use/change[4]. The key words used were "poverty AND deforestation", "income AND deforestation", "deforestation AND agriculture" and "deforestation AND economics". From the resulting studies, only those that discussed the causes of deforestation were retrieved. The second stage is to use the references of these studies to locate other studies that may be of use. These were also retrieved using the same methods. We also reviewed some 400 deforestation studies from our personal collection.

The final dataset consisted of studies containing regression estimates for deforestation that used poverty as the independent variable (i.e. Equation 1). This straightforward requirement minimizes subjectivity in the selection process. Only one regression was chosen to represent one study. The choice is based on: (i) author's stated preference, (ii) adjusted R^2, (iii) number of variables. More than one regression can be used from a study if they analyze different time periods or geographical areas. A total of 49 regressions from 37 studies were used in the dataset[5].

Analytical Approach

The objective of this paper is to find a pattern in deforestation literature, and answer the questions: Does empirical evidence support the win-win hypothesis between poverty alleviation and combating deforestation? What factors influence these results?

The general functional form used in this study is as follows:

$$Y = f(P, R, S)$$

where Y = dependent variable studied (sign/statistical significance of the poverty coefficient); P= publication characteristics (year published, academic discipline of publication); R= research methods/characteristics (sample size, deforestation measures);

[4] Focus 1 is an online searchable database that contains 1500 bibliographic references to agricultural intensification and deforestation case studies. It can be found at http://129.79.99.180/RIS/RISWEB.ISA
[5] A citations list of the deforestation articles used in this meta-analysis can be obtained from the first author.

S= study characteristics (unit of study, location). Summary statistics of these variables can be found in Table 1.

Table 1 Dataset Summary

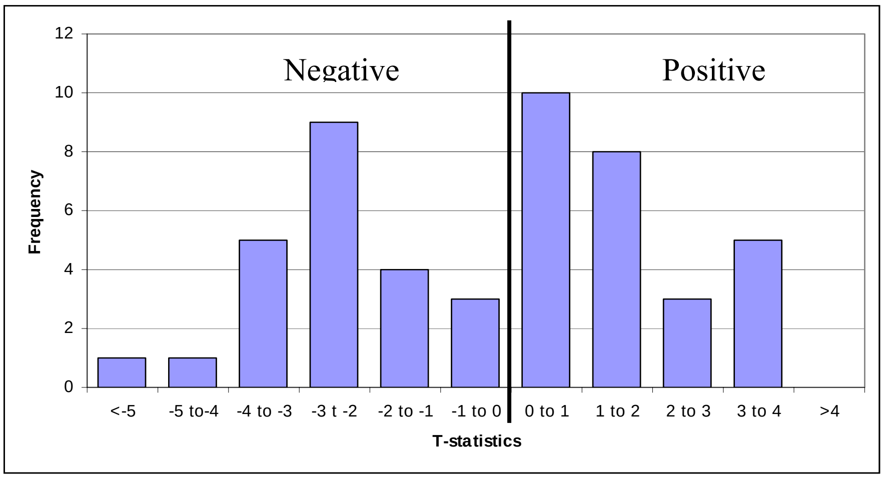
Variables	Classification/range[1]	Datapoints
Dependent Variables		
- Sign of β[1]	Positive Negative Not significant	15 20 14
- T-statistics of β	-18.33 to 4.00	49
Independent Variables		
- Unit of observation	Household Region Country	9 12 28
- Location	Asia Africa Latin America Global[3]	14 6 12 17
- Deforestation Measure	Forest cover change Other measures[4]	28 21
- Publication year	1985 – 2003	49
- Sample size	28-2403	49
- Data source	Primary data Secondary data	21 27
- Publication discipline	Economic Non-Economic	34 15

1. Income is considered the inverse of poverty while forest cover is the inverse of deforestation. The coefficients and t-statistics are converted to show the relationship between poverty and deforestation.

The T-statistics histogram in

Figure 1 roughly follows the normal distribution. One anomaly is the sudden drop in the –2 to 0 range, making the distribution seem ‘lumpy’. This lumpy shape may cause some procedures to result in confirming both negative and positive relationships. If this lumpy distribution is a result of publication bias or some other selection effect, this would imply that our dataset drawn from the literature is not a random sample of all empirical models that have been estimated.

Figure 1 : Distribution of Studies by Significance Level



Description of Methods

Different meta-analysis techniques give different results. Wolf (1986, p.23) states that "As a practical matter, the difference in results among these (combined tests) procedures is slight". However, we choose to use more than one method to validate our results, especially because our sample size is not large (n=49). Three meta-analysis methods were employed in this paper.

Vote-Counting

The dataset was divided into three groups based on the sign of their poverty coefficient: positive, negative or insignificant. It was also stratified based on independent variables (e.g. by location, publication type, etc). The category with the largest proportion of studies (more than one-third) is assumed to give the best estimate of the true relationship between poverty and deforestation.

The hypothesis to be tested is:

$$H0: \beta \leq 0 \quad \rightarrow H0: \theta_{+} \leq 1/3 \text{ and } \theta_{-} \geq 1/3 \quad \rightarrow \text{reject win-win hypothesis}$$

H1: $\beta > 0$ → H1: $\theta_+ > 1/3$ and $\theta_- < 1/3$ → support win-win hypothesis

Where θ_+ and θ_- are the proportion of studies that have positive and negative significant β, respectively.

A disadvantage of the conventional vote-counting method is that as the number of datapoints increase, the probability of making a correct decision tends to zero (Hedges and Olkin, 1985, p.51). This method can be improved using confidence intervals for θ_i, the proportion of studies falling in a category (i=+, -, 0).

$$\theta_i = \hat{\theta}_i \pm C_{\alpha/2}\sqrt{\frac{\hat{\theta}_i(1-\hat{\theta}_i)}{k}}$$

Where θ_i=confidence interval for proportion of observations falling into category i at α significance level, θ_i = proportion of observations falling into category i at α significance level, $C_{\alpha/2}$= critical t-value at $\alpha/2$ with k degrees of freedom, and k = total number of observations.

Combined Tests

Total sample size in the studies ranged from 28 to 2403, with a median of 199. We can hence assume that the errors from these regressions are normally distributed. This allows us to use the normal distributions table to convert t-statistics of the poverty coefficient to p-values, which are used in this class of meta-analytical methods.

These methods assume that observed p-values taken from a continuous variable have a uniform distribution, regardless of their underlying distributions. Three of 49 regressions do not use continuous poverty measures,[6] but they are still included in the analysis because all are from a set of only 9 household studies.

Three non-parametric procedures were used. Some of these procedures are two-tailed tests. In these tests, the dataset was divided into two subsets: negative and positive t-statistics. Tests are run to confirm whether the alternative hypothesis $\beta \neq 0$ is supported in each subset. These methods are susceptible to the missing data problem. If there is a bias against a subset of the data, then the number of observations is too low for the test to be accurate. Judging by the anomaly in Figure 1 this problem is likely to occur.

The test procedures are:

<u>Uniform Distribution Method (Tippett's Procedure[7])</u>

[6] Mertens, et al, 2000 (well being before, during and after economic crisis), Sunderlin, et al, 2001 (dummy for worse off after currency crisis), and Walker, et al, 2000 (wealth class of household)
[7] Tippett 1931 as cited in Hedges and Olkin 1985.

If all the observations are independent and if p_1 is the smallest of a series of p-values, then the test is to see if p_1 is larger than the critical value:

Reject H0 if $p_1 < 1 - (1-\alpha)^{1/k}$ or if $|T_1| > C_1$

For the hypothesis: H0: $\beta = 0$ versus H1: $\beta \neq 0$.

Where α = significance level , k = number of studies, T_1 = smallest t-value, C_1 = critical t-value corresponding to p= $1 - (1-\alpha)^{1/k}$. If p_1 is very close to 1 (absolute t-value is close to zero) given the number of studies, then a relationship between the independent and dependent variable is not likely to exist.

A generalization by Wilkinson (1951) allowed us to use the r-th smallest p-value in the series[8]. Using the 2nd smallest p-value may be more robust if the 1st smallest is an outlier.

The Inverse Chi-Square Method (Fisher's Test[9])

If there are K independent observations with p-values $p_1, \ldots, p_k$, Fisher's procedure uses the product $p_1 p_2 \ldots p_k$ to combine the p-values. If U is a set of values that has a uniform distribution, then $-2 \log U$ has a chi-square distribution with 2 degrees of freedom. The sum of a chi-square distribution also has a chi-square distribution. The test is to:

Reject H0 if $P = -2\ \Sigma_i \log p_i > C_\alpha$

For the hypothesis: H0: $\beta = 0$ ($P \leq C_\alpha$) versus H1: $\beta \neq 0$ ($P > C_\alpha$)

Where C_α = critical value from the upper tail of the chi-square distribution with 2k degrees of freedom at α significance level, and P = Fisher's test statistics. If p_i is close to 1 (t-statistics near 0), then log p_i will be close to zero. The probability of being larger than the critical value and thus rejecting the null hypothesis decreases.

Means Testing

The means testing procedure test whether the mean t-statistics is significantly different from zero. Unlike the two other combined test procedures, this method does not require negative and positive t-statistics to be tested separately. The test is to:

Reject H0 if $\mu = \left(\frac{\sum_i t_i}{k} \right) \pm C_{\alpha./2,k} \frac{\hat{\sigma}}{\sqrt{k}} \neq 0$

For the hypothesis test: H0: $\beta = 0$ (μ includes 0) versus H1: $\beta \neq 0$ (μ does not include 0)

[8] The table for critical values for the r-th smallest p-value is displayed in Hedges and Olkin 1985, p. 37.
[9] Fisher, 1932 as cited in Hedges and Olkin 1985.

Where μ = confidence interval of the mean t-statistics at $\alpha/2$ significance level, $\hat{\sigma}$ = sample standard deviation, t = t-statistics, $C_{\alpha/2,k}$ = critical t-value at k degrees of freedom and $\alpha/2$ significance level. If the average t-statistics is not significantly different from zero, the relationship between the independent and dependent variables is not likely to exist.

Meta-Regression of T-statistics

Meta-regression is the most widely used meta-analysis technique in economics. Since the focus of this paper is the direction and significance of the effect of poverty on deforestation, we use the t-statistics of β (the coefficient for poverty) as the dependent variable in a linear OLS model. Studies that support the win-win thesis, for example, will have a large positive t-statistics.

There are 11 independent variables used to explain these t-statistics. Continuous variables are the year of publication and sample size. The others are dummy variables for household and country studies; studies in Asia, Africa, and Latin America; the use of primary forest cover data; the use of forest cover change as measure of deforestation; and studies published in economic outlets (journals that publish primarily studies by economists and working papers by economists).

V. RESULTS

The results of these procedures are described below. To gain more understanding of the available literature and the dynamics between poverty and deforestation, the dataset for vote-counting and combined test procedures was sub-divided following Table 1. Due to space constraints, we only present the implications for our hypothesis about poverty and deforestation, rather than the specific numerical results of all tests, in Table 2.

Results from Tippett's procedure proved to be of little use since it shows that all sub-categories both support and reject the win-win hypothesis.

White's statistics suggested that there was heteroskedasticity in the initial meta-regression model. Further investigation revealed that it was linked with the sample sizes used in each study. This problem was circumvented by using weighted least squares and removing sample size as an independent variable. An outlier was removed (t-stat = -18.33) as it greatly affected the estimates.

Out of 10 dependent variables, only the dummy variable for economic publications was significant. Results from studies found in economic journals or working papers tend to have less positive t-statistics than the average. They do not support the win-win hypothesis as much as studies found elsewhere. This also means that non-economic publications tend to support the win-win hypothesis more than other studies, which is consistent with previous meta-analysis tests.

Table 2 Summary of Results

Subcategory	Vote Counting	Fisher's Test	Means Test
All Studies	Reject win-win		No relationship
By Unit of study			
Household		No relationship	
Regional		Support win-win	
Country	Reject win-win, Support win-lose		
By Location			
Asia	Reject win-win, Support no relationship	Reject win-win	
Africa		No relationship	
Latin America			
Global			
By Deforestation Measure			
Forest Cover Change	Reject win-win	Reject win-win	
Others			
By Publication Year			
Before 2000	Support win-lose		
2000-2003	Support no relationship		
By Number of Samples			
<=100			
>100	Reject win-win		
By Data Source			
Primary	Reject win-win, Support no relationship	Reject win-win	
Secondary			
By Publication Discipline			
Economics	Reject win-win, Support win-lose		
Non-Economic	Reject win-lose, Support no relationship	Support win-win	Support win-win

VI. CONCLUSION

Meta-analysis has proven to be an efficient tool for extracting patterns that would otherwise be buried under a seemingly amorphous body of literature. Based on the results of five meta-analysis procedures, the following lessons can be drawn:

(i) the win-win hypothesis is not supported by the majority of empirical studies that used regression analysis to explain deforestation

(ii) many of these studies provide evidence for negative or no relationship between poverty and deforestation

(iii) estimates found in non- economic publications are more likely to support the win-win hypothesis, all else being equal
(iv) different meta-analysis methods lead to different conclusions; more than one method should be used to confirm results.

It should be noted that the studies reviewed in this paper are not perfect, and individually, they may not reveal the 'true' relationship between the parameters. However, meta-analysis is an effective way to find empirical regularities and extract lessons from the overall literature. Our results clearly show that regression modeling does not support for policies that assume alleviating poverty leads to reduced deforestation. This conclusion may be an important point for future policy-making, and a reminder that there is a wide gap between policy-making and research.

REFERENCE

Angelsen, A. 1997. The poverty-environment thesis: was Brundtland wrong? Forum for Dev Studies. 1: 135-154.

Arrow, K, Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C.S., Jansson, B.O., Levin, S., Mäler, K.G., Perrings, C., and D. Pimentel. 1995. Economic growth, carrying capacity, and the environment. Science. 268: 520-521.

Cropper, C. and C. Griffiths. 1994. The interaction of population growth and environmental quality. Amer Econ Rev. 84: 250-254.

Deininger, K.W. and B. Minten. 1999. Poverty, Policies and Deforestation: the Case of Mexico. Econ. Devel. Cult. Change. 42: 313-344.

Duraiappah, AK. 1998. Poverty and environmental degradation: a review and analysis of the nexus. World Dev. 85(2): 238-243.

Fisher, R.A. 1932. Statistical methods for research workers (4th ed). Oliver and Boyd, London, England. 319 p.

Grossman, G.M., and A.B. Krueger. 1995. Economic growth and the environment. Quart. J. Econ. 110: 353-377.

Geist, H.J., and E.F. Lambin. 2001. What Drives Tropical Deforestation? A Meta-Analysis of Proximate and Underlying Causes Of Deforestation Based On Subnational Scale Case Study Evidence. LUCC Report Series No.4. University of Louvain, Louvain-la-Neuve, Belgium. 116 p.

Hedges, L.V., I. Olkin. 1985. Statistical Methods for Meta-Analysis. Academic Press, Orlando, FL. 369 p.

Holtz-Eakin, D. and T.M. Selden. 1995. Stoking the fires? CO_2 emissions and economic growth. J. Pub. Econ. 57: 85-101.

Jones, J.R. 1990. Colonization and Environment: Land Settlement Projects in Central America. United Nations University, Tokyo, Japan. 168 p.

Kaimowitz, D., and A. Angelsen. 1998. Economic Models of Tropical Deforestation: a Review. CIFOR, Bogor, Indonesia. 139 p.

Mather, A.S., Needle, C.L., and J. Fairbairn. 1999. Environmental Kuznets Curve and forest trends. Geography. 84: 55-65.

Reed, D. (ed.) 1992. Structural Adjustment and the Environment. WWF International. Westview Press, Boulder, CO. 209 p.

Rudel, TK.1993. Tropical Deforestation: Small Farmers and Land Clearing in the Ecuadorian Amazon (with B. Horowitz). Columbia University Press, New York, NY. 234 p.

Rudel, TK. 1998. Is there a forest transition? Deforestation, reforestation, and development. Rural Soc. 63(4): 535-552.

Selden, T., and D. Song. 1994. Environmental quality and development. J Environ Econ Manage, 27:147-162.

Sunderlin, W.D. and J.A. Rodrigues. 1996. Cattle Broadleaf Forests and the Agricultural Modernization Law of Honduras: The Case of Olancho. CIFOR Occasional Paper no. 7(E). CIFOR, Bogor, Indonesia. 28 p.

Tippett, L.H.C. 1931. The Methods of Statistics. Williams & Norgate, London, England.

Wibowo, D.H. and R.N. Byron. 1999. Deforestation mechanisms: a survey. Intl J Soc Econ. 26:455-474.

Wilkinson, B. 1951. A statistical consideration in psychological research. Psych. Bul. 48: 156-158.

Wolf, F.M. 1986. Meta-Analysis: Quantitative Methods for Research Synthesis. Series: Quantitative Applications in the Social Sciences, No.59. Eds. Sullivan, JL; Niemi, RG. Sage Publications, Beverly Hills, CA. 65 p.

Wunder, S. 2000. The Economics of Deforestation: The Example of Ecuador. St. Martin’s Press: New York. 262 p.

Wunder, S. 2001. Poverty alleviation and tropical forests – what scope for synergies? World Devel. 29: 1817-1833.

Zeller, M., Lapenu, C., Minten, B., Ralison, E., Randrianaivo, D., and C. Randrianarisoa. 1999. Pathways of rural development in Madagascar: an empirial invesitgation of the critical triable between environmental sustainability, economic growth and poverty alleviation. Q J Int Agric. 38:105-127.

Assessment of the Economic Importance of Mississippi Outfitters and Opportunities for Expansion[1]

Xing Sun[2], Ian A. Munn[3], Emily Loden[4], Anwar Hussain[5], and Stephen C. Grado[6]

ABSTRACT

Wildlife outfitters play an important role in rural economies by attracting hunters and other wildlife recreationists into rural areas. Expenditures by outfitters and their clientele represent important monetary inputs for local economies. Understanding the nature and magnitude of these expenditures is essential to fostering rural economic development. In 2003, survey questionnaires were mailed to all known outfitters operating in Mississippi. The questionnaire was designed to elicit information about their property, business, and socioeconomic characteristics. In addition, questions about outfitter socio-economic characteristics, attitudes, and outreach-related needs were included. Outfitters engaged in fee hunting received $4.14 net revenue per acre per year, not accounting for the cost of capital invested. Although fee-hunting operations were their primary revenue source, outfitters also derived 34% of their gross revenue from other wildlife-related activities such as fishing and wildlife viewing.

KEYWORDS: wildlife outfitters, fee hunting, survey, business characteristics

---

[1] This manuscript is publication #FOXXX of the Forest and Wildlife Research Center, Mississippi State University.

[2] Graduate Research Assistant, Department of Forestry, Mississippi State University, Box 9681, Mississippi State, MS 39762. xs31@msstate.edu (662) 325-8358 (v); (662) 325-8726 (fax).

[3] Professor, Department of Forestry, Mississippi State University, Box 9681, Mississippi State, MS 39762. imunn@cfr.msstate.edu (662) 325-4546 (v); (662) 325-8726 (fax).

[4] Research Associate, Department of Forestry, Mississippi State University, Box 9681, Mississippi State, MS 39762.

[5] Research Associate, Department of Forestry, Mississippi State University, Box 9681, Mississippi State, MS 39762. ahussain@cfr.msstat.edu (662) 325-4259 (v); (662) 325-8726 (fax).

[6] Professor, Department of Forestry, Mississippi State University, Box 9681, Mississippi State, MS 39762. sgrado@cfr.msstate.edu (662) 325-2792 (v); (662) 325-8726 (fax).

Assessment of the Economic Importance of Mississippi Outfitters and Opportunities for Expansion

Xing Sun, Ian A. Munn, Emily Loden, Anwar Hussain, and Stephen C. Grado

INTRODUCTION

Forest resources are a major contributor to Mississippi's economy. Many rural areas still rely on forestry and the forest product industry and have not shifted into other activities to diversify revenues (Wear and Greis 2002). Mississippi's rural economies are relatively depressed compared other areas in the state. Mississippi's forests, however, provide recreational wildlife opportunities in addition to raw materials for the forest product industry. Commercial outfitting, fee hunting, and other wildlife-related recreational enterprises can play an important economic role in Mississippi because they operate in rural areas where outfitter and client expenditures can stimulate local economies. Outfitters can serve as a middleman between recreationists and landowners. As a result, local economies can benefit from the establishment of a well-developed wildlife-based recreational industry.

In addition to the economic impacts generated by hunter expenditures, commercial outfitters also produce environmental benefits as well. Outfitters may be inclined to afforest marginal agricultural land, protect ecologically diverse forests and wetlands, and improve wildlife habitat quality without the intervention of environmental regulations. Producing high quality, natural settings for hunters is one way to increase returns by attracting additional hunters and other recreationists. Although many studies have evaluated economic impacts of outfitters on rural economies (Henderson et al. 2004, Davis et al. 2002, Jones et al. 2001, Burger et al. 1999, Grado et al. 1997), comprehensive information about outfitters' property, business, and socio-economic characteristics is not available. This research will provide useful base-line information about the industry to landowners who may be considering outfitting as a business venture, other outfitters as a means to identify their market niche and opportunities, and policy makers to identify the importance of this industry to Mississippi's rural economies. Industry information will identify relevant costs, revenues, and activities of outfitting operations, and further classify outfitter operations by size, land type, and economic scale.

METHODS

In 2003, survey questionnaires were mailed to 122 outfitters and guides known to be operating in Mississippi. Names were obtained from the Mississippi Outfitters and Guides Association and the Mississippi Outfitters Association, the two active professional organizations in the state, and a comprehensive internet search. Fifty-one responded, resulting in a 42% response rate.

The questionnaire was designed to elicit information about their property, business, and socioeconomic characteristics. Property characteristics included ownership size, composition by land use type (forest, agriculture, other), game species, and wildlife/habitat management practices. Business characteristics included types of wildlife-related activities offered, amenities provided, payment methods, revenues, and costs. Socioeconomic characteristics consisted of demographic characteristics, outfitter attitudes about fee hunting, and informational needs.

Data analysis for this report consisted of computing the means and relative frequency distributions for key survey questions to provide descriptive statistics of wildlife outfitters operating in Mississippi.

RESULTS

Property Characteristics

Land size and use: The average land base size dedicated to an outfitter operation was 2,794 acres. Sixty-one percent of respondent outfitters reported more than 1000 acres in their operation (Figure 1). Of this total, 52% was owned in fee by the outfitter and 48% was leased from other landowners. Forestry was the dominant land-use, and accounted for 59% of the land dedicated to outfitting operations. Bottomland hardwoods accounted for 44% of forestlands dedicated to outfitter operators. Planted pines accounted for 18%. Agriculture accounted for 34% of the total and other miscellaneous land-uses, the remaining 7% (Figure 2). Row crops accounted for nearly all agricultural land dedicated to outfitter operators.

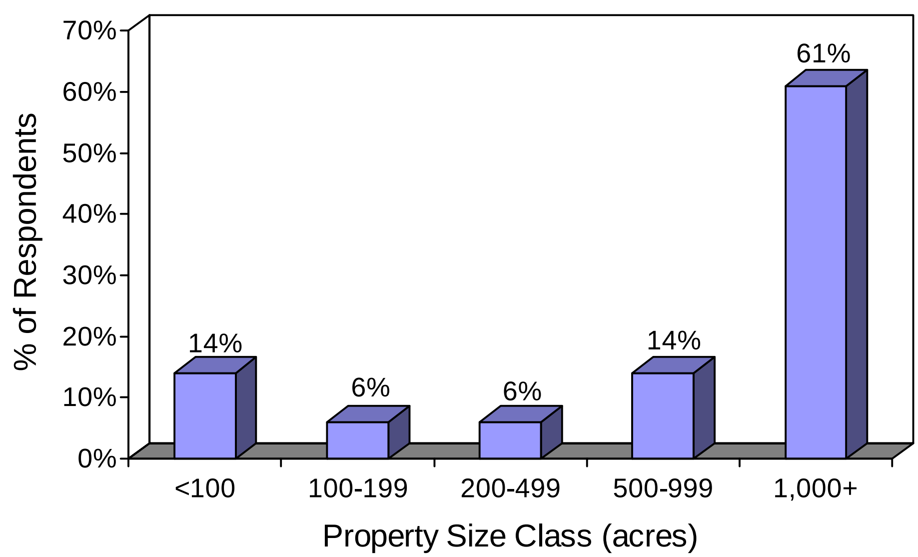


Figure 1. Size of land base operated by outfitters in Mississippi during 2003

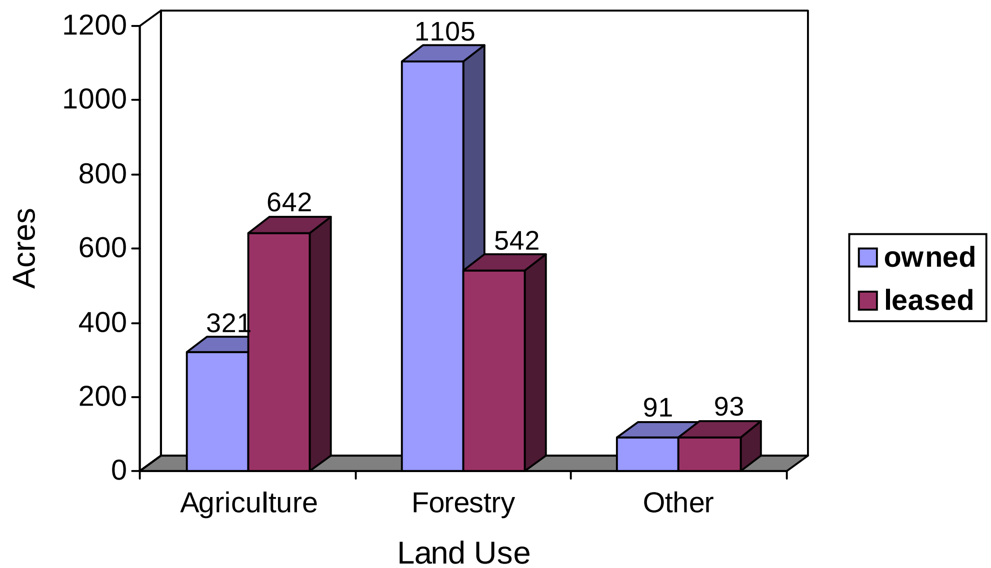


Figure 2. Average acreage dedicated to Mississippi outfitter operations by land use and sources in 2003

Legal arrangements between outfitters and landowners: Seventy-two percent of respondents had written lease agreements with landowners to secure hunting rights; however, 45% also relied on informal agreements (Figure 3). Outfitters often secured hunting privileges from several landowners.

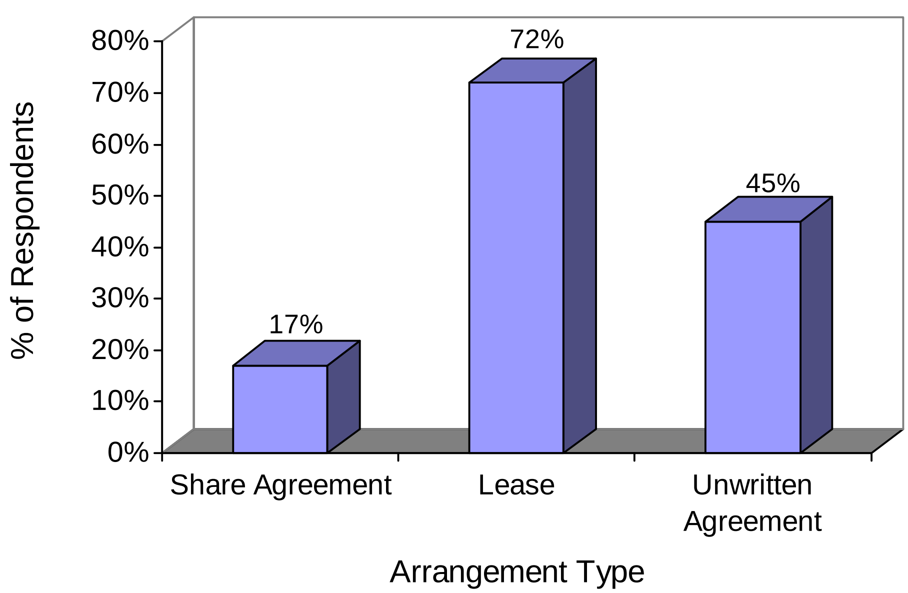


Figure 3. Lergal arrangements between Mississippi outfitters and landowners in 2003

Game species offered to clientele: Most outfitters provided hunting opportunities for multiple game species. Deer was the predominant species hunted, provided by 61% of outfitters. Waterfowl was the next largest category at 39%. Many species, such as squirrel, hog, and rabbit, were provided as incidental hunting opportunities in addition to the primary species, e.g., deer, turkey (Figure 4).

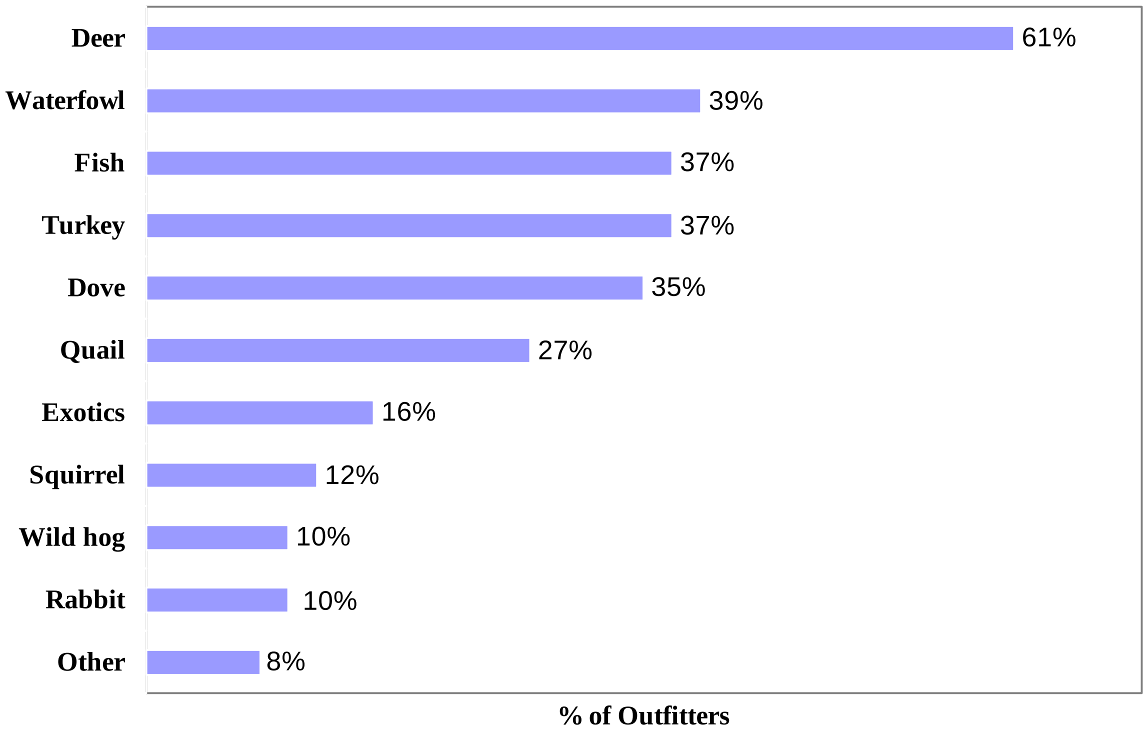


Figure 4. Game species provided by Mississippi outfitters in 2003

Business Characteristics

Amenities/services provided by outfitters: The majority of outfitters provided guides, lodging, food, transportation, and game processing (Table 1). Although the major source of revenue was hunting fees, providing miscellaneous services generated additional revenues. In general, commercial outfitters provided elaborate food and lodging services (Figure 5).

Wildlife management practices conducted by outfitters included establishing food plots, disking, leaving unharvested crops, providing salt/mineral licks, and managing predators, by 78%, 68%, 66%, 54%, and 50% of respondents, respectively.

Table 1. Services/amenities offered by Mississippi outfitters in 2003

Amenity/Service Provided	**% of Respondents**
Guides	94
Lodging	80
Food and Food Plots	76
Transportation	74
Blinds	72
Game Cleaning	60

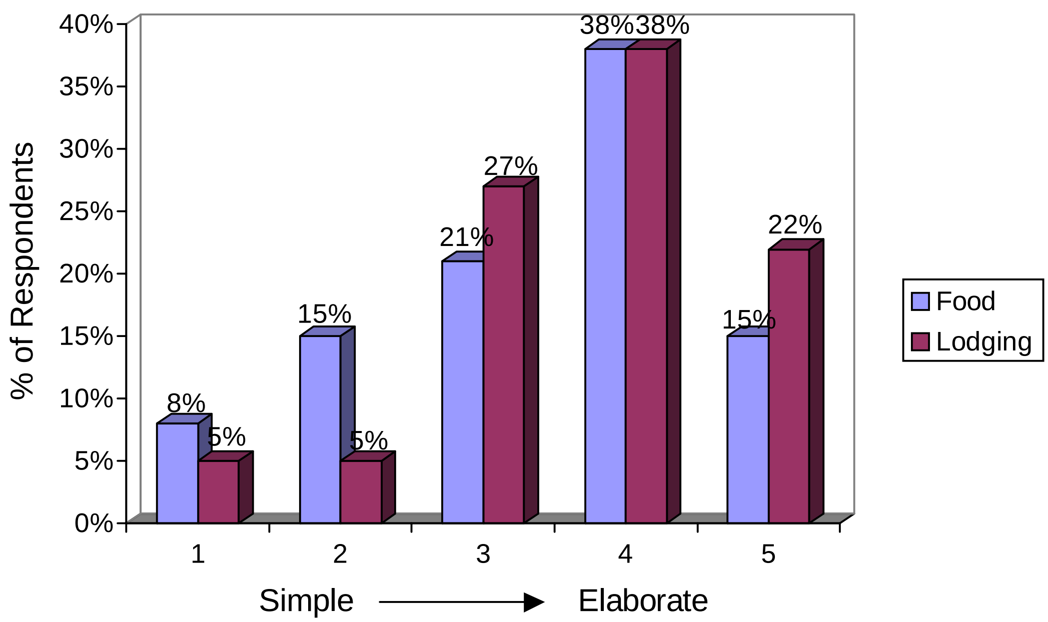


Figure 5. The quality of food and lodging services provided by Mississippi outfitters in 2003

Revenues, costs, and net revenues:

Outfitters derived revenues from fee-hunting activities and non-consumptive activities such as wildlife watching. Hunting and fishing revenues, however, clearly dominated. Eighty-four percent of respondents reported fee-hunting revenues and 29% reported fishing revenues while 10% reported horseback riding revenues and 8% reported wildlife watching. Gross revenues averaged $77,000 per year. Of the respondents reporting revenue data, 61% reported fee hunting as the sole source of wildlife-related revenue.

Twenty-six percent reported other wildlife-related income in addition to fee hunting. Thirteen percent reported other wildlife-related income but none from fee hunting. Fee hunting revenues varied considerably between respondents with most (55%) reporting less than $20,000; however, 13% earned more than $100,000 (Figure 6). In contrast, of the 39% of respondents who reported revenues from non fee-hunting activities, 25% earned less than $20,000 per year from these activities. Five percent, however, earned more than $100,000 per year (Figure 7). Capital investment in outfitting operations varied considerably (Figure 8). Over 37% of respondents had over $350,000 invested in their business. Almost 40% of respondents reported less than $100,000 invested. Annual operating expenditures averaged $67,000 across all respondents (Figure 9). Salaries, wages, and benefits represented almost $34,000 of this total. Payments to landowners were the next largest expense. Annual net revenues averaged $4.14/acre/year.

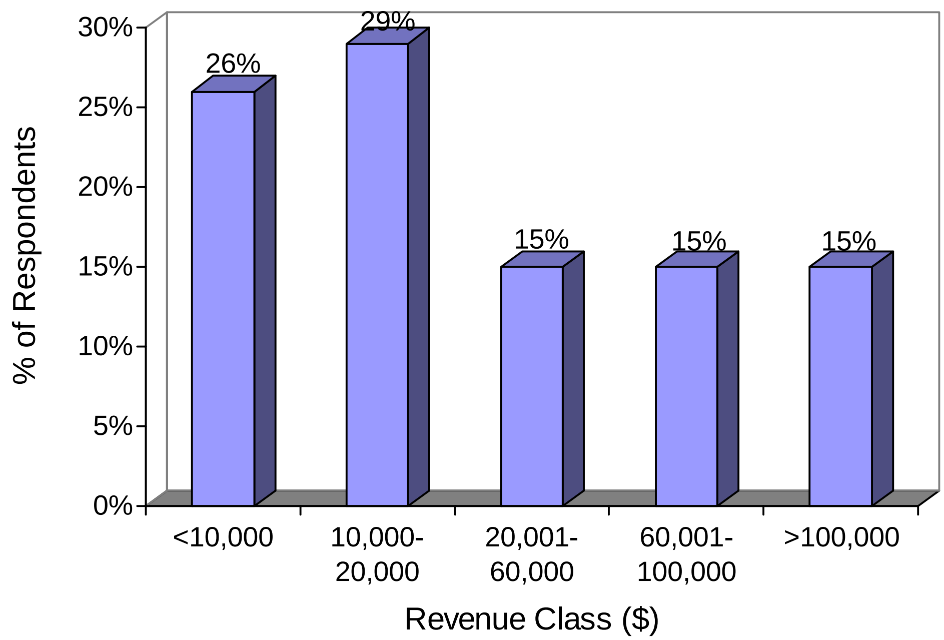


Figure 6. Revenue distribution from fee-hunting by Mississippi outfitters in 2003

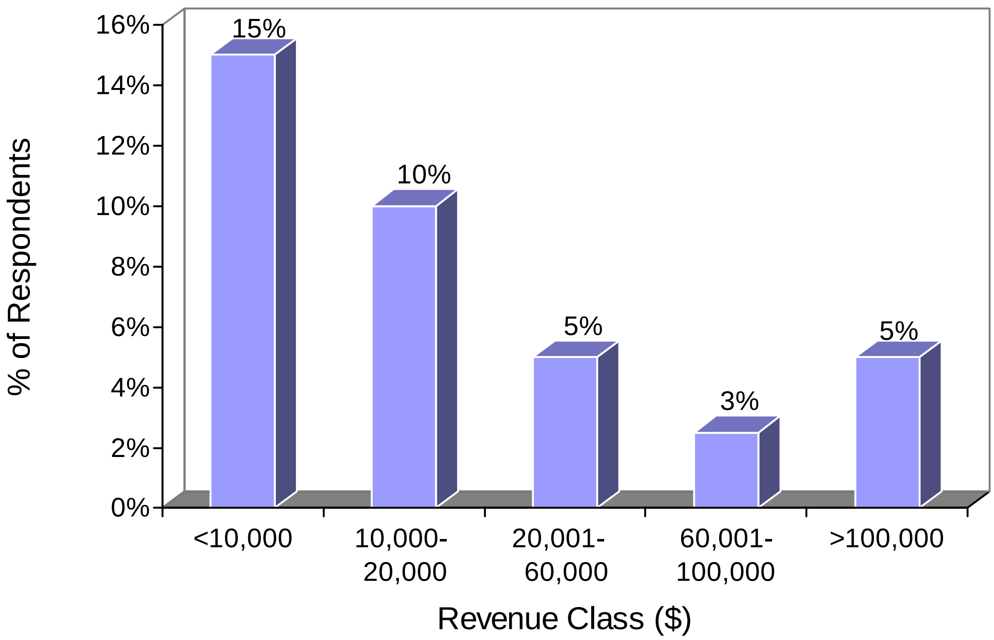


Figure 7. Revenue distribution from non fee-hunting wildlife recreation by Mississippi outfitters in 2003

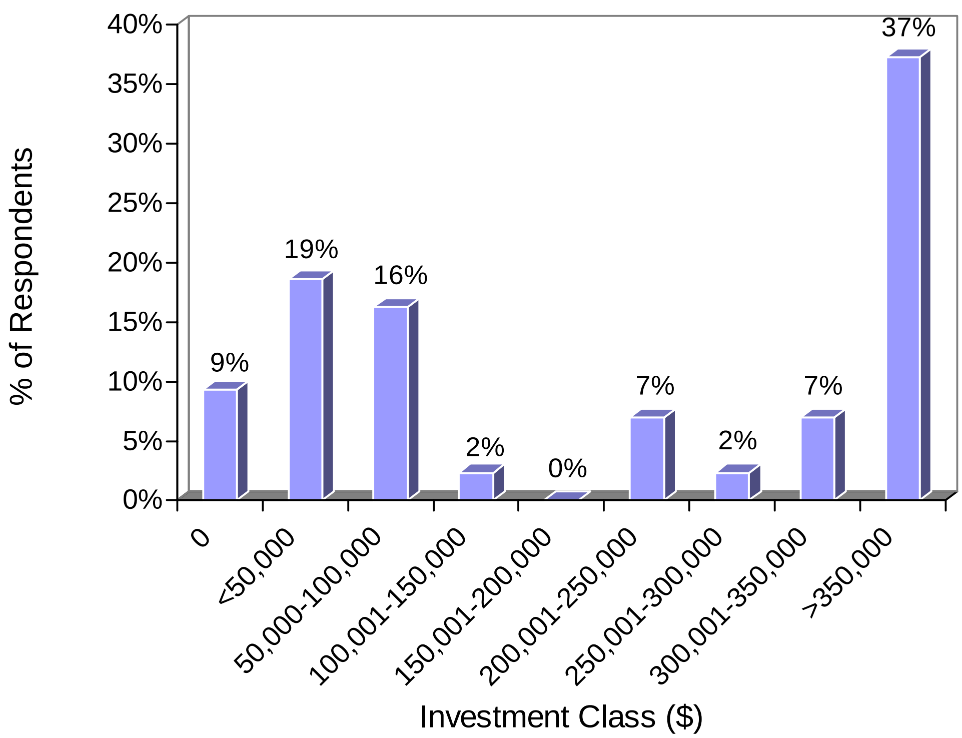


Figure 8. Investment in facilities and equipment by Mississippi outfitters in 2003

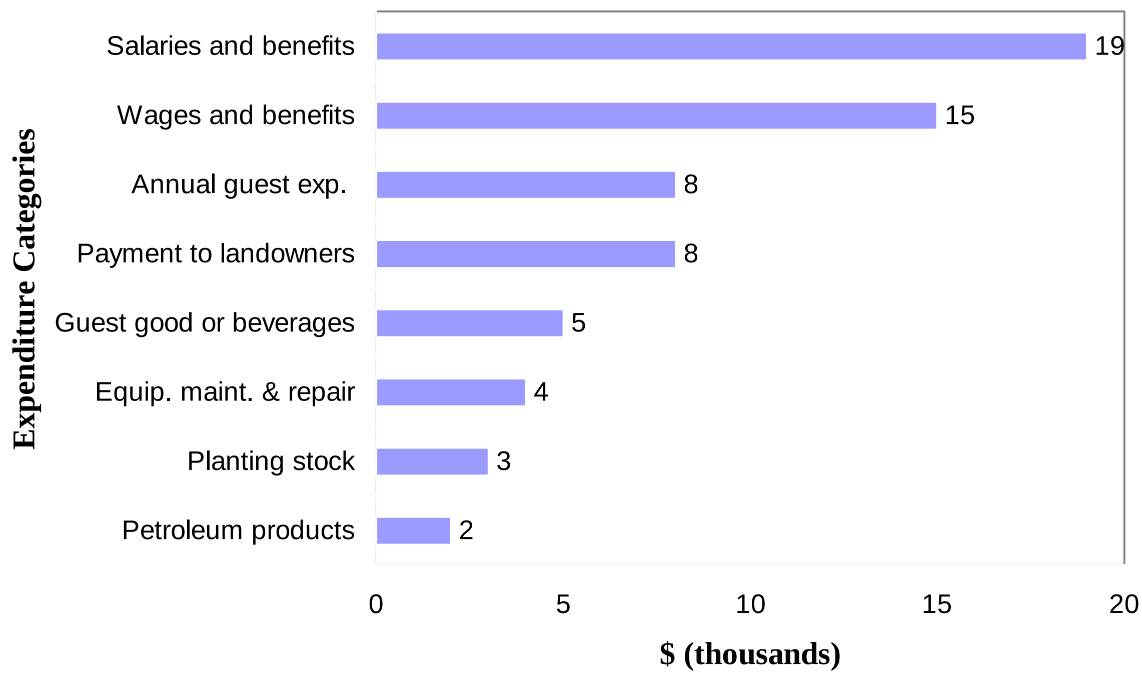


Figure 9. Average annual expenditures by category for Mississippi outfitters in 2003

Socio-economic characteristics of Mississippi Outfitters

Outfitters were typically well-educated, Caucasian males over 50 years old. Forty-four percent of the respondents had completed college and an additional 28% had completed junior college. In general, outfitters were very affluent. Forty-seven percent reported household incomes over $100,000 and 17% reported household incomes between $80,001 and $100,000 (Table 2).

Table 2. Socio-economic characteristics of Mississippi outfitters in 2003

Highest Educational Level Completed	% of Respondents
High School	28
Jr. College	28
College	44
Age	**% of Respondents**
> 50	53
40- 49	23
< 40	24
Annual Household Income ($)	**% of Respondents**
20,001-40,000	14
40,001-60,000	17
60,001-80,000	9
80,001-100,000	17
> 100,000	43

DISCUSSION

This study provided an overview of Mississippi outfitters, their land bases, and some fundamental financial information pertaining to the outfitter industry. Several key findings were worth noting. First, outfitters varied considerably with respect to the size of their land base and capital investment suggesting that these two factors were not necessarily barriers to entry. Landowners with limited resources can still establish viable outfitting operations. Second, most outfitters leased additional land from private landowners indicating that opportunities exist for landowners to participate in the outfitting business, at least indirectly, without outfitting expertise. Previous studies (e.g., Jones et al. 2001) indicated that landowners working with outfitters received substantially higher returns than those leasing directly to hunting clubs, suggesting that landowners amenable to fee-hunting may be inclined to work with outfitters. In combination, these points indicated that the expansion of the outfitting industry is possible in Mississippi. The third point is that economic contributions to rural economies from the outfitting industry are substantial, compared with other wildlife industries. With average expenditures of $67,000 per year, Mississippi's 122 outfitter and guide businesses contribute over $8,000,000 directly to rural economies. Clientele expenditures can boost this total. Where game populations will tolerate additional hunting pressure, promoting the outfitting business is a mutually beneficial to outfitters, landowners, and rural economies.

Literature Cited

Arano, K.G., and I.A. Munn. 2004. Nonindustrial private forest landowners' forest management activities and expenditures in Mississippi, 1998-2000 data. Forest and Wildlife Research Center, Bulletin FO249, Mississippi State University. 13p.

Burger, L.W., D.A. Miller, and R.L. Southwick. 1999. Economic impact of northern bobwhite hunting in the southeastern United States. Wildlife Society Bulletin 27(4):1010-1018.

Davis, S.A., S.C. Grado, and I.A. Munn. 2002. Economic impact of commercial outfitters in Mississippi. P. 127-130 in Proceedings of the 2001 Annual Southern Forest Economics Workers Meeting, Atlanta, GA. March 27-28, 2001.

Grado, S.C., A. Hurst, and K.D. Godwin. 1997. Economic impact and associated values of the wild turkey in Mississippi. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 51:438-448.

Guan, H., and I.A. Munn. 2001. An analysis of new capital expenditures by the forest products industry in the Pacific Northwest. P. 291-294 In Proceedings of the 2001 Southern Forest Economics Workers Meeting, Atlanta, GA. March 27-28, 2001.

Henderson, J.E., S.C. Grado, and I.A. Munn. 2004. Economic impact of commercial hunting outfitters and clientele. P.397-402 in Proceedings of the 2003 Southern Forestry Economics Workers Meeting. New Orleans, LA. March 17-18, 2003.

Jones, W.D., I.A. Munn, S.C. Grado, and J.C. Jones. 2001. Fee hunting: An income source of Mississippi's nonindustrial private landowner. Forest and Wildlife Research Center, Bulletin FO164, Mississippi State University. 15p.

Munn, I.A., E.K. Loden, S.C. Grado, J.C. Jones, and W.D. Jones. 2004. Comparing hunting lease prices: A price decomposition approach. P. 193-200 in Proceedings of the 2004 Southern Forestry Economics Workers Meeting, St. Augustine, FL. March 14-16, 2004.

Wear, D.H., and J.G. Greis. 2002. Southern Forest Resource Assessment. Southern Research Station. General Technical Report SRS-53. P. 175-250.

Concurrent Session 2B: Laws and Regulations

Impact of Forestry-Related Ordinances on Timber Harvesting in St. Tammany Parish.

by

James Henderson[1], Tina Willson[2], Mike Dunn[3], and Richard Kazmierczak[4]

[1] Graduate Research Assistant, Louisiana State University, Department of Agricultural Economics and Agribusiness, 101 Agricultural Administration Building, Baton Rouge, LA 70803. jhend19@lsu.edu. (225) 578-2758.
[2] Graduate Research Assistant, Louisiana State University, Department of Agricultural Economics and Agribusiness.
[3] Associate Professor, Louisiana State University, Department of Agricultural Economics and Agribusiness, 101 Agricultural Administration Building, Baton Rouge, LA 70803. mdunn@agcenter.lsu.edu. (225) 578-0344.
[4] Professor, Louisiana State University, Department of Agricultural Economics and Agribusiness. rkazmierczak@agctr.lsu.edu. (225) 578-2712.

Impact of Forestry-Related Ordinances on Timber Harvesting in St. Tammany Parish.

Abstract

The proliferation of forestry-related ordinances is a growing trend in the Southern United States, with the greatest expansion of regulations in regions with growing populations that are in close proximity to urban areas. St. Tammany Parish in Louisiana is an excellent example of an increasingly exurbanized area that has passed ordinances deemed by many in the forestry community as being excessive both in terms of cost and regulatory rigor. In this study, we investigated if the passage of such ordinances has had an effect upon pine sawtimber harvesting activities in St. Tammany Parish. Results indicate that a significant negative relationship exists between a $10,000 road bond ordinance and the level of sawtimber harvest in the Parish.

Key Words: ordinances, regulation, timber harvest, urbanization, exurbanization

Introduction

A growing trend of concern to many in the forestry community is the proliferation of state and local government regulations of forestry practices on private land (Hickman 1993; Granskog et al, 2002; Jackson, 2003). Granskog et al. (2002) updated previous work by Martus (1992) and found that the total number of local ordinances had more than doubled across 13 southern states from a total of 141 in 1992 to 346 in 2000. Granskog et al. (2002) concluded that this pattern of growth in ordinances has continued since 1970 with the number of ordinances doubling every 5 years. Forestry-related ordinances are typically used to regulate harvesting activity, minimize damage to public roads, and to preserve environmental and aesthetic quality. However, ordinances passed at the local government level are of particular concern since these are often developed independently and without a full understanding of possible economic consequences (Green and Hains, 2001; Jackson et al., 2003). Additionally, such forestry-related ordinances often have unpredictable impacts on local forestry operations and the unintended consequence of reducing long term timber supply when landowners accelerate harvest to avoid new regulation they consider burdensome (Cubbage, 1991; Greene and Siegel, 1994).

A major factor in the increase of ordinances is a shift in population from urban areas to more rural settings. Former urban dwellers generally have fewer economic and personal ties to rural agriculture and forest economies and are therefore less likely to see a rationale for timber harvesting activities (Hickman, 1993). Granskog et al. (2002) linked the growth of local government ordinances to social conflicts resulting not only from the growth of urban areas, urbanization, but also to exurbanization, the migration of urban residents to rural areas. The new rural residents typically are unfamiliar with the historical importance of forestry to a local economy and react adversely to the unpleasant appearance of harvested areas by organizing community movements and lobbying local government to pass ordinances that are restrictive to forestry practices, often without considering the effectiveness of the ordinance itself or the economic impact on the local economy.

A number of studies have surveyed the existence of forestry-related ordinances across the South and have grouped them into one of five categories that included public property ordinances, timber harvesting ordinances, tree protection ordinances, environmental protection ordinances, and special feature or habitat protection ordinances (Hickman and Martus, 1991; Hickman 1993; Greene and Siegel, 1994; Spink et al., 2000; Granskog et al., 2002). Public property ordinances are intended to protect public roads and bridges from damage resulting from timber harvesting activity as well as to ensure public safety. Timber harvesting ordinances are adopted to restrict certain types of forestry or silvicultural operations and generally require adherence to best management practices and require harvest permits. Tree protection ordinances are intended to preserve trees as land is developed. Environmental protection ordinances seek to protect environmental and aesthetic values by retaining forested tracts. Special feature or habitat protection ordinances are designed to protect scenic or environmentally valuable area by requiring the use of aesthetic management zones.

Of the five types of ordinances discussed in the literature Hickman (1993) indicated that the most popular regulatory ordinances in the South are those directed at the protection of public property. Granskog et al. (2002) also indicated that public property protection ordinances account for nearly half of all ordinances in the South. The passage of such property protection ordinances has grown from 59 in 1992 to 158 in 2000 (Granskog et al., 2002). Ordinances of this type have the potential for negative economic impacts given that a common regulatory requirement of such ordinances is the posting of a performance bond that can range from $1,000 to $25,000 (Hickman, 1993).

St. Tammany Parish, located just north of New Orleans, Louisiana is a prime example of an increasingly exurbanized area that has passed ordinances deemed by many in the forestry community as being excessive both in terms of cost and regulatory rigor (Jackson et al., 2003; Martus, 1992). From 1970 to 2003, the population of St. Tammany parish has nearly tripled. This growing exurbanized population coupled with the historic role that forestry plays in the local economy, along with the proliferation of forestry related ordinances, presents an interesting opportunity for empirical analysis.

Previous empirical work in estimating the impact of forestry-related ordinances is limited primarily to assessing the growth of ordinances and their perceived impact through surveying logging and forestry professionals (Greene and Haines, 1994; Martus, 1992; Martus et al, 1995; Spink et al., 2000; and Granskog et al., 2002). A limited number of studies have looked at relationships beyond surveys of existing ordinances and perceptions of those affected by them. Stier and Martin (1997) investigated the economic impact of a state level regulation in Wisconsin affecting a six county region along the Wisconsin River. The regulation required private landowners to leave buffer zones along the banks of the river. Kittredge et al. (1999) compared stumpage values over five years for two adjacent states (Massachusetts, which has extensive forestry related regulations, and Connecticut, which has extremely limited regulations) and found that such regulations do not adversely affect stumpage or landowner profits. As far as the authors are aware, no study has attempted to estimate a relationship between the timber harvest rates and forestry ordinances that are directly related to timber harvesting activities. The objective of this study is to evaluate the potential consequences of forestry-related ordinances by determining if the passage of such ordinances has had an effect upon timber harvesting activities. This will be investigated by modeling the relationship between timber harvesting practices and the passage of forestry-related ordinances in St. Tammany Parish. Harvest levels will be modeled as a function of stumpage prices, population, time, and forestry-related ordinances. The ordinances will be incorporated into the models through the use of dummy variables.

Data

The Code of Ordinances for St. Tammany Parish published December 31, 2002 was examined to determine adoption dates for ordinances that are forestry related. Section 12-003 defines the provisions for the land clearing permit that include the purchase price of the permit at $150, cost for inspection of $100, and requirements for a natural uncut buffer zone of at least fifty feet in width surrounding a harvest area. The provision also allows for only one access opening which can not exceed one hundred linear feet. The proceeding requirements of Section 12 of the Code of Ordinances for St. Tammany Parish are defined collectively by six ordinances which were not defined individually. The ordinances that comprise the requirements of Section 12 were adopted in 1984, 1985, 1986, and three adopted in 1987. St. Tammany Parish Land Use Ordinance No. 523 Section 5.17 requires that a road bond in the amount $10,000 be posted by anyone who obtains a land clearing permit. This provision became effective on October 1, 1990. The provisions of the land clearing permit and the road bond are examples of what the literature refers to as timber harvesting and public property protection ordinances, respectively. Dummy variables were created for each of the individual ordinances enacted in 1984, 1985, and 1986, and for the road bond policy enacted in 1990. Another dummy variable was created to collectively account for the three ordinances enacted in 1987.

Stumpage prices for the state of Louisiana and the level of pine sawtimber harvest by parish since 1970 to 2003 were compiled (Louisiana Department of Agriculture and Forestry, 2004). The Louisiana Department of Agriculture and Forestry maintains a record of annual stumpage prices and timber harvested by parish as recorded through the collection of severance taxes from harvesting activities. Timber harvest data indicates the volume of Pine sawtimber harvested per thousand board feet (Mbf). Stumpage prices for Pine sawtimber were converted from nominal to real dollars using the 1982 Producer Price Index for lumber and wood products (Bureau of Labor Statistics, 2004). Population estimates for St. Tammany Parish for 1970 to 2003 were obtained from the U.S. Census Bureau (2004). Annual precipitation data for St. Tammany parish was obtained from for the years 1970 to 2003 (National Oceanic and Atmospheric Administration, 2004).

Methodology

A time series model was used to investigate the relationship between forestry-related ordinances and timber harvest levels in St. Tammany Parish. The model takes the following general form:

$y_t = \beta_1 + \beta_i x_{it} + \delta\, y_{t-1} + \varepsilon_t, \qquad \varepsilon_t \sim IID(0,\sigma^2).$

where the path of a variable y_t is described in terms of contemporaneous and often lagged factors x_{it} for i= 1,2,..n, its own past y_{t-1}, and disturbances ε_t (Greene, 2003). Our initial model consisted of timber harvest as the dependent variable while the independent variables included stumpage price, population, time, lagged timber harvest, and dummy variables for each year a forestry-related ordinance was active in St. Tammany parish.

Estimation of models like the one described above are often not straightforward due to the presence of the lagged dependent variable. When working with time series data, it is important to test for nonstationarity before proceeding with estimation (Kennedy, 1998). We can test for nonstationarity by using Dickey-Fuller unit root tests (Davidson and MacKinnon, 2004). If a unit root is present, then ordinary least squares estimation is not valid. Additionally, time series models often have autocorrelation problems, and when a model contains autocorrelation and a lagged dependent variable, least squares estimates are biased and inconsistent. The Durbin-Watson h statistic (Greene, 2003) was used to test for the presence of autocorrelation within the model. Autocorrelation is often a sign of a misspecified model. An additional problem of hetroskedasticity is also often present in time series models. White's test for hetroskedasticity (Greene, 2003) was also performed on the model.

Since no prior work has attempted to estimate a relationship between the timber harvest rates and forestry-related ordinances that are directly related to timber harvesting activities, no clear guidelines existed for determining what variables were necessary for inclusion in the model. Economic theory requires that stumpage price be included in the model. Since harvest in one period is directly influenced by the previous period's harvest, a lagged harvest variable should also be included. Timber harvest levels may also be influenced by a wide range of factors that include the discount rate, U.S. housing starts, logging cutbacks in other regions due to restrictive legislation such as the Endangered Species Act, the level of Canadian wood imports, and exchange rates (Rucker et al., 1999). For the purposes of simplifying the model these numerous exogenous effects were internalized by expressing sawtimber harvest for St. Tammany Parish as a ratio of the total sawtimber harvest for the state of Louisiana. Since the afore mentioned exogenous factors should affect timber production in Louisiana equally across all parishes, expressing harvest levels in St. Tammany as a ratio of state totals preserves needed degrees of freedom in the estimation when the time series is as limited as it is in this study. Harvest of pine sawtimber relative to the total harvest levels in Louisiana is depicted in Figure 1.

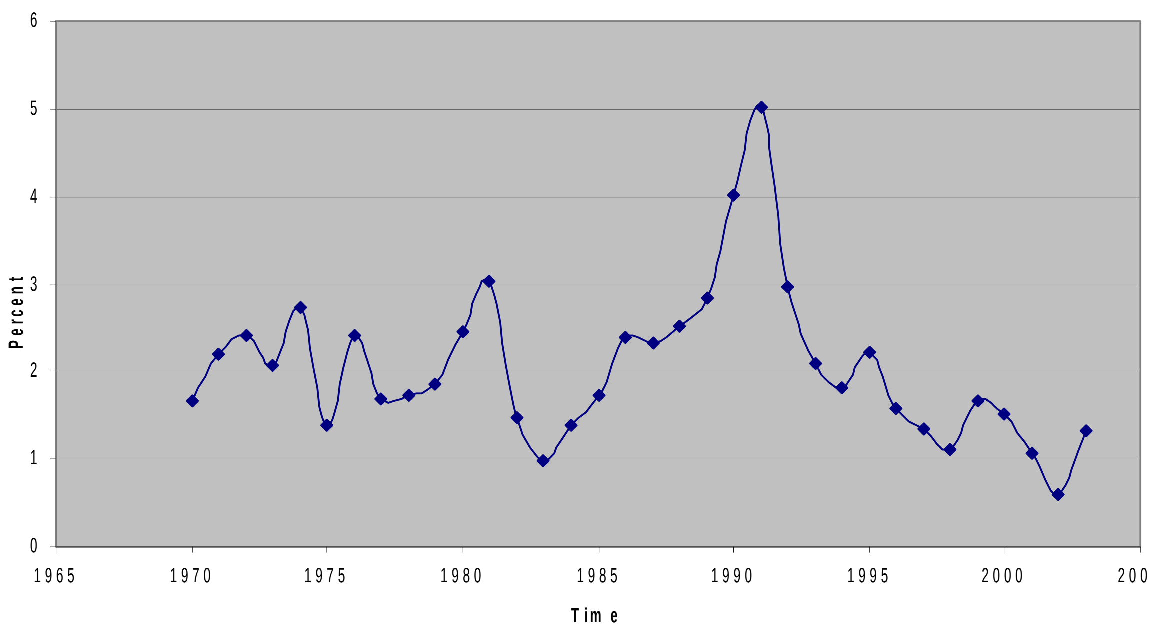


Figure 1. Sawtimber Harvest in St. Tammany as Percentage of State Harvest over time (1970 – 2003).

Notice the surge in harvest levels just prior to the 1990 implementation of the land use ordinance requiring a \$10,000 road bond. Greene and Siegel (1994) indicated that ordinances can have the unintended consequence of accelerating harvest levels as landowners attempt to avoid new regulations they consider burdensome. By modeling harvest as function of ordinances and other relevant variables we will investigate whether a significant relationship exists between reductions in harvest levels in St. Tammany Parish and forestry-related ordinances.

The Ramsey RESET test (Greene, 2003) was used to test for omitted variables in the model for sawtimber. If the test indicated that the model was misspecified, additional variables were included until a satisfactory model was determined. If an added variable did not improve adjusted R^2 and did not rectify the omitted variable problem, it was subsequently dropped from the model.

Sawtimber Model and Results

The initial sawtimber harvest model included the variables stumpage price, population, time, lagged timber harvest, and dummy variables for each year a forestry-related ordinance was adopted in St. Tammany parish. Although testing indicated no problems with autocorrelation or heteroskedasticty, the RESET test indicated that the model was misspecified so additional variables were examined for inclusion in the model. These variables included rainfall, population at lags up to 5 years, and harvest lagged up to 5 years. The model that was ultimately chosen is as follows:

$$STHarvest_t = \beta_0 + \beta_1 Time_t + \beta_2 Population_t + \beta_3 Bond + \beta_4 Ordinance1984 + \beta_5 Ordinance1985 + \beta_6\ Ordinance1986 + \beta_7\ Ordinance1987 + \beta 8STStumpaget + \beta 9STHarvestt_{-1} + \beta_{10} Population_{t-3}$$

where $STHarvest_t$ is St. Tammany pine sawtimber harvest in year t expressed as a ratio of total Louisiana pine sawtimber harvest in year t, $Time_t$ is the year, $Population_t$ is St. Tammany parish population in year t, Bond is a dummy variable indicating years that the \$10,000 road bond is in place, Ordinance1984, Ordinance1985, Ordinance1986, and Ordinance1987 are dummy variables representing the implementation of forestry-related ordinances in those respective years and the subsequent years the ordinances are in place, $STStumpage_t$ is the real Louisiana stumpage price for pine sawtimber in year t, $STHarvest_{t-1}$ is the ratio of St. Tammany pine sawtimber harvest to total Louisiana pine sawtimber harvest in year t-1,and $Population_{t-3}$ is St. Tammany parish population in year t-3.

It is expected that time, the lagged harvest variable, and stumpage will be positive in sign. Time was included to account for technological change in harvest practices, and as technology improves, harvest is expected to increase as well. Lag of harvest should also positively impact harvest. Higher stumpage prices serve as motivation for land owners to harvest timber resulting in a positive relationship. Population and the 3-year lagged population are expected to negatively impact harvest. As population increases harvesting activities are theoretically assumed to decrease (Granskog et al., 2002) and lagging the population by three years may account for the period of time that is needed for new residents to become involved in local political activities. The expected signs of the bond and ordinance variables are unknown and the primary focus of this study, although the authors hypothesize that the bond variable will negatively impact harvest due to its relatively large financial obligation relative to the other ordinances. Regression results are shown in Table 1.

Table 1. Sawtimber Regression Results

Variable	Coefficient	Std. Err	t	P>|t|
time	.0049505	.0022191	2.23	0.037*
population	-4.17e-07	3.43e-07	-1.21	0.239
bond	-.0250197	.0060423	-4.14	0.001*
ordinance1984	.0088232	.006416	1.38	0.184
ordinance1985	.0064636	.0078158	0.83	0.418
ordinance1986	.0067809	.0074985	0.90	0.377
ordinance1987	-.0051651	.0077699	-0.66	0.514
stumpage	.0001204	.0000668	1.80	0.087**
harvest_lag	.4899198	.1418349	3.45	0.003*
population_lag3	-7.16e-07	4.56e-07	-1.57	0.132
intercept	-9.700696	4.348196	-2.23	0.037*

* significant at 5% level
** significant at 10% level

R^2= 0.7766
adj R^2= 0.6649
F(10,20) = 6.95
Prob > F = 0.0001

All variables have the expected signs, but only time, bond, and the lagged harvest variable are significant at the 5% level and stumpage is significant at the 10% level. Adjusted R^2 for the regression is 0.6649 indicating that 66.49% of the variation in sawtimber harvest is explained by the model. Since results indicate the absence of a unit root and autocorrelation, the regression estimates are unbiased and consistent. However, we also tested for multicollinearity and found that time, population, and the 3-year lagged population variables are significantly correlated. This means that we can be confident that the variables indicated as significant are indeed significant. However, we cannot be certain that the variables that did not test significant are actually not significant due to the inflated variances of these coefficients resulting from the multicollinearity. The effects of the ordinances passed in 1984, 1985, 1986, and 1987 were inconclusive, but the road bond policy had a negative impact of 2.5 % on St. Tammany's percent of state sawtimber harvest levels.

Discussion

This study analyzed possible relationships between local forestry-related ordinances and the harvesting of timber. Significant relationships were found between the road bond policy and harvest levels in the saw timber model, but the effects of the other forestry-related ordinances are inconclusive.

The decrease in sawtimber harvest can be attributed to the fact that non-industrial private land owners often do not maintain forest land for reasons of profitability or as a source of income (Adams et al., 1982). Therefore non-industrial private forestland owners would be inclined to hold timber rather than harvest. The road bond ordinance indicates that the $10,000 security could be posted by either party involved in the timber sale. In the case of non-industrial private forestland owners this security is typically bonded by the logging firm. The requirement of $10,000 increases fixed costs for logging firms and may have the effect of reducing the number of firms that are willing to operate in St. Tammany parish and therefore reduce the number of timber harvesting bids.
For these reasons it is not surprising to find a significant negative relationship between the road bond ordinance and timber harvesting in St. Tammany parish.

Based on our models, no conclusions can be made regarding the effect of the other six ordinances pertaining to the land clearing permit on harvest levels. It is assumed that any kind of additional regulation is typically not preferred by those who are regulated, but the degree of financial burden resulting from the provisions of the land clearing permit may not burdensome enough to have a significant impact on harvest levels. More research is needed to test this hypothesis.

This study was limited by the data accessible for estimation. The variables available were limited as was the time period spanned by the variables. This research could be improved upon by collecting more data. Future research could include the estimation of a panel data model to examine the effects of forestry-related ordinances in all of the parishes in Louisiana, and possibly bordering areas in states such as Arkansas and Mississippi. Data would need to be collected on ordinances in each parish, as well as well as data that is national in scope such as housing starts and Canadian wood imports.

Conclusions

The obvious impact that the St. Tammany road bond ordinance has on harvest levels provides possible indication of diminished property values for forest land. Our model indicates that the passage of the $10,000 road bond has a significant negative relationship with harvesting in St. Tammany parish, and it is reasonable to assume that this may have a negative impact on land value used for timber production purposes. This result should be of interest to other local governments in Louisiana since the State Legislature passed amendments in 1995 to the Louisiana Agricultural Protection Act that prohibits local governments from enacting any ordinances that diminish the value of timberland.

References

Adams, D.M., R.W. Haynes, G.F. Dutrow, R.L. Barber, and J.M. Vasievich. (1982) Private Investment in Forest Management and the Long-Term Supply of Timber. American Journal of Agricultural Economics. Vol. 64 (2) 232-241

Bureau of Labor Statistics. Producer Price Indexes. U.S. Department of Labor. November 3, 2004 http://www.bls.gov/ppi/home.htm.

Cubbage, F.W. 1991. Public regulation of private forestry: proactive policy responses. Journal of Forestry. 89(12): 31-35.

Davidson, R. and MacKinnon, J.G. 2004. Econometric Theory and Methods. New York, NY:Oxford University Press

Granskog, J.E., T. Haines, J.L. Greene, B.A. Doherty, S. Bick, H.L. Haney, Jr., S.O. Moffat, J. Speir, and J,J. Spink. Chapter 8: Policies, Regulations, and Laws. In: Wear, D.N. and J.G. Greis, eds. 2002. Southern forest resource assessment. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 635 p.

Greene, J.L. and Haines, T.K. 1994. Estimating the effect of State and local regulation on private timber supply. In: Wear, D.N.; Talmon, J., comps. Proceedings of the southern forest economics workshop. Durham, NC: Duke University. pp. 119-129.

Greene, J.L. and W.C. Siegel. 1994. *The status and impact of state and local regulation of private timber supply*. U.S.D.A. Forest Service General Technical Report RM-255. So. For.Expt. Stn., New Orleans, LA. pp. 22.

Greene, W.H.. 2003. Econometric Analysis (5th ed) Upper Saddle River, NJ:Prentice Hall.

Gujarati, D. N. 1995. Basic Econometrics (3rd ed). Singapore: McGraw-Hill.

Hickman, C.A. 1993. Local regulation of private forestry. Forest Farmer 52(3): 19.21.

Hickman, C.A. and C.E. Martus. Local regulation of private forestry in the eastern United States. In: Chang, S.J., comp. Proceedings of [the] Southern Forest Economics Workshop. Washington, D.C., Feb.20-22, 1991. Louisiana State University, Louisiana Agricultural Expt. Station. pp.73-87.

Kennedy, Peter. 1998. A Guide to Econometrics(4th ed). Cambridge, MA: MIT Press.

Kittredge, D.B., M.G. Rickenbach, and S.H. Broderick. 1999. Regulation and stumpage prices: a tale of two states. *Journal of Forestry*. 97(10):12-16.

Jackson, B., B. Hubbard, J. Sringer, and D. Dillaway. 2003. A look at county and municipal timber harvesting ordinances. Forest Landowner. March/ April 42-45.

Louisiana Department of Agriculture and Forestry. October 11, 2004 http://www.ldaf.state.la.us/

Martus, C.E. 1992. The distribution and objectives of local forestry-related ordinances in the United States. Blacksburg, VA: Virginia Polytechnic Institute and State College. 308 p. M.S. thesis.

Martus, C.E., H.L Haney, Jr. and W.C. Siegel. 1995. Local forest regulatory ordinances: trends in the Eastern United States. *Journal of Forestry*. 93(6): 27-31.

National Oceanic and Atmospheric Administration. National Climatic Data Center. November 30, 2004.
http://www4.ncdc.noaa.gov/cgiwin/wwcgi.dll?WWDI~StnSrch~Name~slidell~LA

Rucker, R.R., W.N. Thurman, and J.K. Yoder. 1999. An economic analysis of the determinants of lumber futures price movements. Bozeman: Montana State University, Department of Agricultural Economics and Economics. Research Discussion Paper no. 37. 48 p.

Spink, J.J., H.L. Haney, Jr., and J.L. Greene. 2000. *Survey of local forestry-related ordinances and regulations in the South*. In Proceedings of the Southern Forest Economics Workshop. Lexington, KY. pp. 41-46.

Stier, J.C. and A.J. Martin. 1997. Economic impact of timber harvest regulations in the lower Wisconsin state riverway. *Northern Journal of Applied Forestry*. 14(3): 126-134.

U.S. Census Bureau, Population Division. October 18, 2004
http://www.census.gov/popest/archives/

Incentives for Biodiversity Conservation on Non-Industrial Private Forests: An Analysis of Landowners' Participation

Jagannadha Matta[1], Janaki Alavalapati[2] and Evan Mercer[3]

Abstract

Although non-industrial private forests (NIPF) provide significant habitat for a variety of species, limited information is available on *how landowners would respond to the adoption of practices that promote biodiversity conservation on their lands.* We examined NIPF landowner preferences for adopting four such practices-- extending timber rotation age, extending riparian buffer strips, periodic prescribed burning, and invasive species control-- through a survey of forestland owners in Florida. Employing an attribute- based choice experiment technique, we analyzed how landowners' willingness to enroll in various incentive programs are influenced by their socio-economic characteristics and by the program attributes. Results of the multinomial logit model indicate that landowners with higher income, education, and more years of forestland ownership are more willing to adopt the suggested forest practices. Besides providing valuable insights in designing optimum incentives to further wildlife habitat on NIPF lands, the results of this study also underline the need for enhanced education and outreach efforts on these practices for increasing landowner participation.

[1]Post-doctoral Associate, School of Forest Resources and Conservation, University of Florida, Gainesville, FL 32611. Email: raojm@ufl.edu

[2] Associate Professor, Forest Policy and Economics, School of Forest Resources and Conservation, University of Florida, Gainesville, FL 32611. Email: janaki@ufl.edu

[3] Research Economist, US Forest Service, Southern Research Station, PO Box 12254, RTP, NC, 27709. Email: emercer@fs.fed.us

1. Introduction

Forests in Florida comprise over 6.5 million hectares and contribute over $7 billion annually to the state's economy (Carter and Jokela 2002). NIPF owners own about half of these lands. Besides providing invaluable economic, social, recreational, and environmental services, these NIPF are also home to several threatened and endangered species such as the red cockaded woodpecker, gopher tortoise, and flat wood salamander. Owing to several development pressures, however, many of these lands face a high risk of habitat degradation (Kautz and Cox 2001) and a variety of management practices are suggested to promote forest health and habitat for wildlife on these lands. Prominent among these practices are periodic prescribed burning, removal of invasive species, delaying timber harvesting beyond the financially optimal rotation age, and creation and/ or maintenance of streamside management zones (SMZ) to protect riparian buffers (Matta and Alavalapati, forthcoming).

The thrust for fostering the adoption of the above four biodiversity-enhancing management practices mostly comes from the societal benefits they produce. Delaying timber harvesting and maintaining extended riparian buffers to improve habitat for wildlife on NIPF were also suggested earlier in contexts elsewhere (e.g. Kline et al 2000a and 2000b). Wildfires are a recurrent phenomenon in pine forests in Florida for thousands of years and there is a perception that fire suppression in recent years has significantly impacted the native forest ecosystem (Long 2002). Consequently, periodic prescribed burning is advocated as a major mechanism to protect and restore native flora and fauna. Similarly, invasion of alien species is widely recognized as a major threat to the ecological integrity of native ecosystems (Jose et al. 2002).

Past studies on the prevalence of these practices indicate that very few landowners actually pursue them. For example, the SFRA (2002) report indicates that only about 11% of the landowners in the US South undertake practices that improve wildlife habitat. Specifically with regard to NIPF in Florida, English et al. (1997) noted that less than a third of large (40+ hectare) landowners implement practices designed to enhance timber growth, improve wildlife habitat, protect water quality, and /or enhance scenic values. Protection of wetlands was also cited as the least frequently used conservation practice by these landowners. Further, Jacobson (1998) observed that about 47% of NIPF owners in Florida were not actively managing their lands. One of the reasons for not actively managing forestlands was the investment cost needed for their active management (Jacobson 1998). In fact, the SFRA (2002) report observes that doing nothing is considered to be a practical and cost-effective approach for many landowners. There is, however, a possibility of landowners agreeing to follow biodiversity-enhancing management practices if they are offered economic incentives (Shogren et al. 1999). In this paper we develop a predictive model to understand landowner participation in such an incentive program and estimate corresponding willingness-to-accept (WTA) values.

Other significant factors that often determine the effectiveness of a conservation program are the number and distribution of land parcels that get enrolled (Parkhurst et al. 2002). Besides effectiveness from a biological point of view, when a larger number of landowners in a specific area participate, implementation and monitoring costs per landowner could be lower. From an individual landowner point of view, the costs and risks, if any, associated with implementing the program to him/ her may be smaller with higher participation rates due to the ability of nearby landowners to exchange information and experiences. Particularly, for practices such as prescribed burning and invasive species control, the unit costs of implementing them would be lower when a larger number of landowners enroll. Therefore, we were interested in examining if the number of participating landowners in a program influences landowner decision on his/her participation. Accordingly, we have also included variables representing this dimension in our model.

The objective of this paper is to examine the willingness of landowners to adopt such biodiversity-enhancing management practices. Specifically, using data from a survey of NIPF owners in Florida, we analyze how land, landowner, and program characteristics influence NIPF landowner participation in an incentives program designed to provide habitat for biodiversity.

Past studies indicated how different program characteristics influence landowner participation. However, these studies have not examined how landowner preferences vary with different combinations of characteristics of incentive program alternatives. By focusing on program characteristics and associated utility measures, this paper provides critical information on not only the attributes of a conservation program that attract landowners most but also the extent of incentive payment involved for various alternatives. Of late, several states are developing comprehensive regional wildlife conservation plans specifically to provide habitat for rare and threatened species at landscape levels. This paper could help improve the success and sustainability of such efforts by providing a mechanism to identify program elements that would ensure effective participation of landowners. The remainder of the paper is organized as follows. Section 2 presents the conceptual framework of the model. Section 3 details the data collection methods and analysis. In Section 4, results are presented and finally, a summary and policy implications of the findings are presented in Section 5.

2. Conceptual Framework of the Model

In an ACE design, the products or services tested for respondents' preferences are presented as sets of distinct attributes (or features) with variations (or levels) in each attribute (feature). This allows the researcher to capture the trade-offs people make between the attributes of alternative goods and services and their levels and estimate the probability of people choosing different attribute combinations (Louviere 1988; 1994). In analyzing the adoption potential of the proposed four biodiversity enhancing practices, for example, the landowners evaluate trade offs associated with each practice, as well as different levels within a practice. As such, the ACE technique can be used to assess how landowners prefer different attributes of the management practices, what economic and non-economic criteria influence their preferences, and finally, determine the characteristics of a conservation package that would most likely be adopted.

Following Holmes and Adamowicz (2003) and Shrestha and Alavalapati (2004), we applied the attribute-based choice experiment (ACE) design to model and analyze landowner decision to participate in a conservation incentive program and estimate the corresponding WTA values. Random utility theory (McFadden 1974) provides the theoretical basis for attribute-based choice experiment (ACE) modeling and value estimation. The technique uses repeated choice process in value elicitation and analyses respondent's choice preferences. The basic assumption underlying the theory is that the true but unobservable utility of a good or service j is composed of both deterministic (v) and random components (ε). Applying this technique to our study, we consider each attribute (management practice) of the conservation program as an alternative j in a choice set C. The alternative j is a specific alternative representing a change in management with its conditional indirect utility level U_j for a landowner and is expressed as:

$$U_{ij} = v_{ij} + \varepsilon_{ij} \qquad (1)$$

The selection of alternative j over alternative h implies that the utility of U_{ij} is greater than that of U_{ih}. The utility is random as while the respondents know with certainty their choices, the researcher's knowledge is stochastic since it is based only on the observed behavior of respondents during the choice experiment. Accordingly, the probability of an individual i choosing alternative j, $p(\cdot)$, is expressed as:

$$p(ij|C) = p[U_{ij} > U_{ih}] = p[(v_{ij} + \varepsilon_{ij}) > (v_{ih} + \varepsilon_{ih})], \quad j \neq h \qquad (2)$$

Assuming that the error terms of the utility function are independently and identically distributed (IID) and follow a type 1 extreme value (Gumbel) distribution) and the choice probabilities have a closed-form solution, they are estimated using a multinomial logit (MNL) specification (Shrestha and Alavalapati 2004). The MNL model indicating the probability of choosing an alternative j (whose utility is greater than the utility of all other alternatives) is represented as:

$$p(ij) = \frac{\exp^{\mu v_{ij}}}{\sum_{ij \in c} \exp^{\mu v_{ih}}} \qquad (3)$$

where μ is a scale parameter.

If utility U_{ij} is assumed to be linear, additively separable, and μ = 1, it can be represented as

$$U_{ij} = \mu(\beta + \beta_1 z_1 + \beta_2 z_2 + \ldots + \beta_n z_n + \beta_a s_1 + \beta_b s_2 + \ldots + \beta_m s_k) \qquad (4)$$

where β is a constant term that can be partitioned into alternative specific constants (ASC), and β_n is the vector of coefficients attached to the vector of program attributes z, and β_m is the vector of respondents' individual characteristics s that influence utility.

We believe that the application of ACE technique is a major improvement from previous studies that mostly looked at whether a landowner participates in a program or not. The ACE technique goes a step forward by providing a predictive understanding of landowners' forestland use decisions and the relative importance of the characteristics of an incentive program desired by them. As such, results of this approach would be more valuable to program planners and conservation agencies in designing appropriate incentive policies and targeting specific potential participants.

3. Data and Analysis

This section describes the survey procedure followed to obtain the data. The names and addresses of NIPF landowners in 4 counties (Alachua, Putnam, Walton, and Bay) in north Florida who owned at least 10 acres of land were obtained from county tax assessor's offices. A mail survey was designed and conducted according to the Total Design Method (Dillman 1978) in the spring and summer of 2005. Several steps were taken to facilitate easy understanding of the items presented in the survey. These include a 4-page information brochure that provided brief descriptions about the role of NIPF in wildlife conservation, conservation incentive programs, and the specific management practices for which landowners' willingness to adopt were being sought. Color photos and drawings of these practices were also used to illustrate them clearly. The initial survey was pre-tested with focus groups of NIPF landowners. After incorporating the changes suggested by the focus groups, the surveys were mailed out to a random sample of 1,500 landowners. A reminder postcard and a second mailing followed the first mailing. Of the original 1500 surveys mailed out, 221 surveys could not be delivered. Of the 1279 delivered, 513 were returned, which gives a response rate of 40.1%. This response rate is within the range of response rates reported earlier for similar valuation surveys (Loomis et al. 2000). Of the 513 surveys that were returned, 400 were considered usable.

Figure 1: Example of a choice set scenario. Four such scenarios are presented in each survey.

SCENARIO –III

Program Requirements	*Program A*	*Program B*	*C*
Minimum Harvestable Age for Timber	50 years	30 years	
Create/Maintain Riparian Buffers	200 ft. width	200 ft. width	
Conduct Prescribed Burns	Once in 4 to 6 Years	Once in 2 to 3 Years	Not interested in enrolling in either program
Invasive Species Control	Once in 5 to 7 Years	Once in 2 to 4 Years	
Landowner Participation in Your County	20% Participate	Less than 1%	
Incentive Payment During the Enrollment Period	$40 per acre per year	$70 per acre per year	$0

Please mark the CHOICE you would prefer: **A** **B** **C**

If you chose A or B, how many acres would you enroll? _________ number of acres

If you chose C, please tell us why you would not want to enroll in the programs presented here:

The survey asked NIPF owners questions about characteristics of their property, past management practices, knowledge of incentives programs, and demographic information. In addition, the survey presented landowners hypothetical incentive programs in 4 choice sets. Each choice set had two options (A, B) representing different combinations of proposed conservation program options and a status-quo option (C), representing current management options. The respondent was asked to choose one of these three options (Figure 1).

Table 1: Definitions of program attributes used for choice experiment

Program attributes	Levels in each attribute
1. Timber Harvesting	a. No restriction. b. Harvesting is permitted only after trees are 30 years c. Harvesting is permitted only after trees are 50 years.
2. Maintaining Streamside Management Zone (SMZ)	a. No change to existing SMZ (at least 35 feet). b. Requires an SMZ of at least 100 feet width. c. Requires an SMZ of at least 200 feet width.
3. Conducting prescribed burning	a. No requirements for conducting prescribed burns. b. Conduct prescribed burns at least once in 2-3 years. c. Conduct prescribed burns at least once in 4-6 years.
4. Invasive species control	a. No requirements for invasive species control. b. Control measures required every 2 to 4 years. c. Control measures required every 5 to 7 years.
5. Landowner participation in the program	a. Less than 1% of landowners in your county enroll. b. 10% of landowners in your county enroll. c. About 20% of landowners in your county enroll.
6. Incentive payment (per acre/year)	\$10, \$20, \$40, \$70

In each attribute, level "a" indicates status quo, level "b" moderate level, and level "c", higher level of restrictions.

Different combination of management practices (attributes) in each of the proposed new option (A or B) in fact represent different levels of the practice and an incentive payment in the form of an annual payment. Each attribute had three levels and the incentive payment four levels (Table 1). In arriving at different combinations of attribute levels in options A and B, we used a random selection process, which is said to generate more precise valuation estimates compared to fractional factorial design commonly used in ACE technique (Lusk and Norwood 2005). Moreover, this random design process allows for detailed examination of attribute interactions beyond main effects.

<u>Data Coding and Model Estimation</u>

As described above, each choice presented in the questionnaire required the respondent to choose one of the two conservation program alternatives to adopt or opt status quo. The respondent repeats this process for four different choice sets. Thus, for each respondent we obtained 12 (4 x 3) data points. An alternative specific constant (ASC) for the status quo option was created by assigning a value of "1" if that line of data described the status quo alternative and "0" otherwise. Variability in choice selection not explained by the attribute or socio-economic variables is captured by ASCs (Holmes and Adamowicz 2003). Effects codes using "1", "-1", and "0" were used to code the variables for the attribute levels. For all our attributes, which have three levels each, the status quo level is chosen as the base and two effects codes variables were created for the other two levels.

The coefficients for these two levels are estimated from the model and the parameter value for the omitted attribute is the negative sum of these coefficients. LIMDEP (1999) discrete routine was used to estimate the resulting multinomial logit regression model (MNL). A detailed overview of data coding and model estimation is provided by Holmes and Adamowicz (2003).

4. Results and Discussion

Descriptive statistics for the study sample indicate that the average sizes of the landholding and forestland are 244.5 and 200.8 acres respectively. The properties are located on an average about 33.3 miles from the nearest city having a population of 50,000 or more. Pine forests are dominant, occupying on an average 45.7% of the forestlands. Wetlands, canals, and other water bodies occupy about 9.8% of the forests while mixed forests and hardwoods constitute 28.1% and 7.5% of them respectively. The average landowner is 61 years old, has owned land for 37 years, received college level education, and earned an annual income of $74,649, much above the average household income of Florida residents ($53,030) in 1999. A majority (78%) of the respondents are male. While 58% of them have residences on their property, it is interesting to note that for 98% of the respondents, forestry is not a major source of income. Only 15% are members of a forestry or conservation organization. Land investment is the most important objective of forestland management for 36% of the respondents, which is followed by timber production (20%), wildlife (14%), aesthetics (13%), and other purposes.

Table 2: Results multinomial logit model

Variable	Coefficient	Standard Error	t-ratio
Parameter in utility function			
HARV30	0.0159	0.0736	0.216
HARV50	-0.3831	0.0777	-4.929
BUF100	0.0643	0.0725	0.886
BUF200	-0.2140	0.0783	-2.734
BURN2	-0.0699	0.0739	-0.945
BURN5	-0.0121	0.0730	-0.165
INV3	-0.0006	0.0732	-0.008
INV6	0.0006	0.0746	0.008
PART10	0.0488	0.0740	0.659
PART20	-0.0177	0.0735	-0.241
INCENT	0.0192	0.0022	8.639
MILES	-0.0072	0.0026	-2.768
YEARS	-0.0071	0.0020	-3.488
GEND	0.1189	0.0816	1.458
INCS	-0.0050	0.0017	-2.983
RES	-0.1521	0.0663	-2.294
ORGZ	-0.3414	0.0884	-3.863
AGE	0.0161	0.0051	3.13
EDU	-0.5181	0.0817	-6.338
ASC	2.9593	0.5272	5.613
McFadden R^2	0.18		
Log-L	-1066.75		
N	4524		

Socioeconomic variables are interacted with the alternative specific constants (ASC).

We estimated the multinomial logit model and tested for IIA restrictions using the Hausman and McFadden test. The test results did not indicate any violation of IIA assumption. Parameter estimates for the base case attribute (status quo) levels were computed as the sum of -1 times the parameter values for the included levels of each attribute. The coefficient on the status quo Alternative Specific Constant (ASC), which indicates the marginal utility of the status quo relative to the proposed program alternatives is significant (5% level) and positive (Table 2). This indicates that, everything held constant, landowners prefer maintaining the status quo to participation in the proposed program.

Coefficients on attribute variables however indicate interesting results demonstrating each practice's effect on landowners' utility function. For example, the forest practice attribute coefficients *HARV50, BUFF200, BURN2, BURN5, INV6* are negative, indicating negative utility to landowners. These practices in fact represent restrictions on management and as such, carry a negative utility with them. Of these five coefficients, however, only those that represent the higher form of restriction- *HARV50* (no harvesting till the age of 50 years) and *BUF200* (maintaining a minimum streamside management zone of 200' width) are significant at $p<0.01$, clearly implying that higher regulations reduce landowners' utility associated with adopting these practices. The coefficient for incentive payment *INCENT*, is positive and significant ($p<0.01$) indicating that incentive payment increases landowners' utility. The percentage of landowners participating in a county did not show any significant effect on individual landowner participation.

The individual-specific variables were interacted with alternative specific constant term (*ASC*). It is interesting to note that the coefficient for the variable *AGE* is positive and significant indicating that the probability of choosing the status quo, everything else held constant, increases if the respondent is older. On the other hand, the variables representing *EDU, INC, YEARS*, are negative and significant suggesting the probability of choosing status-quo decreases if the respondent holds a college degree, has higher income, and owned the land for a longer time. The coefficients for variables *MILES, RES* and *ORG* are also negative and significant which suggests a decrease in the probability of choosing status quo if the property is located farther from a city, if the respondent has residence on property, and if he/she is a member of a forestry or conservation organization. When analyzed together, these results suggest a plausible pattern explaining landowners' participation in an incentive program designed to improve habitat for wildlife. There seem to be a set of landowners holding forestlands close to cities as capital investments and reluctant to participate in forest/wildlife management programs. These are relatively older people, have their main residences located elsewhere from forest property, and are not associated with any forestry or conservation organization.

5. Summary and Conclusions

With the increasing concerns for healthy forests and enhanced habitat for wildlife, private landowner involvement has become a critical component of biodiversity conservation in the US. This study examines the willingness of non-industrial private forest owners of Florida to adopt a conservation program that requires following restrictions beyond the existing BMPs under certain financial incentives. Applying an attribute-based choice experiment design, we assess the adoption potential of the identified biodiversity-enhancing management practices. The results also suggest that younger landowners with higher income, education, and more years of forestland ownership would be more willing to adopt the suggested forest practices. There is also an increased probability of landowner participation if the property is located farther from city, if the landowner has residence on the property, and if he/she is a member of a forestry or conservation organization. While considering these results, however, one has to bear in mind the dynamic nature of NIPF community, particularly as it applies to the southeastern US. Florida has been identified as one of the fastest growing states in terms of residential development in the US and forest areas and rural lands are the primary targets for such alternative land uses. In addition, a significant decline in NIPF tree planting in the US South in the next 50 years is predicted owing to increased plantation costs and reduced levels of external assistance (Kline et al. 2002). There has also been a steady decline in pulpwood and sawtimber prices in this region significantly impacting the profitability of forest management geared toward producing these products. Under these circumstances, a forest landowner's prime motive would be to adopt a land use strategy that maximizes his/her net returns. These factors perhaps explain why there is reluctance on the part of some landowners to undertake these practices. They also provide an empirical basis or justification for extending financial incentives to landowners to ensure the sustainability of family forests in the long run. With the growing importance of science-based policy making, we believe that the landowner attributes and cost estimates provided in the study would be of significant value to all those individuals and organizations interested in furthering biodiversity on NIPF.

Acknowledgements

We thank the National Commission on Science for Sustainable Forestry (NCSSF) for funding this study. We also thank all forestry and wildlife professionals and landowners who participated in our study for their unstinted support and cooperation.

References:

Carter, D.R., and E. J. Jokela.2002. *Florida's Renewable Forest Resources.* Document CIR1433. Gainesville, FL: Florida Cooperative Extension Service, University of Florida.

Dillman, D. A. 1978. *Mail and Telephone Surveys: The Total Design Method.* New York, NY: John Wiley & Sons.

English, B.C., C. D. Bell, G. R. Wells, and R. K. Roberts. 1997. "Stewardship Incentives in Forestry: Participation Factors in Florida." *Southern Journal of Applied Forestry* 21(1) : 5–10.

Holmes, T.P. and W.L. Adamowicz. 2003. Attribute-based Methods. In: Champ, P., K. Boyle, and T.Brown (eds.) *A Primer on Non-market Valuation.* Dordrecht: Kluwer. pp 171-219.

Jacobson, M. G. 1998. Developing Extension Programs for Private Forest Landowners in the Southeast: Are We Putting the Cart Before the Horse. In: Extension Forestry: Bridging the Gap Between Research and Application; 3rd IUFRO extension working party symposium. http://iufro.boku.ac.at/iufro/iufronet/d6/wu60603/proc1998/jacobson.htm. Accessed on November 16, 2004.

Jose, S., J.Cox, D.L. Miller, D.G.Shilling, and S. Merritt. 2002. "Alien Plant Invasions in Southeastern Forests: The Story of Cogongrass. " *Journal of Forestry* 100: 41-44.

Kautz, R. S. and J. A. Cox. 2001. "Strategic Habitats for Biodiversity Conservation in Florida." *Conservation Biology* 15 (1): 55-77.

Kline, J.D., R.J.Alig, and R. L. Johnson. 2000a. "Forest Owner Incentives to Protect Riparian Habitat." *Ecological Economics* 33: 29–43

Kline, J.D., R.J.Alig, and R. L. Johnson. 2000b. "Fostering the Production of Nontimber Services Among Forest Owners with Heterogeneous Objectives." *Forest Science* 46(2): 302–311.

Kline, J.D., B.J. Butler, and R.J. Alig. 2002. "Tree Planting in the South: What Does the Future Hold? *Southern Journal of Applied Forestry* 26 (2): 99-107

LIMDEP, 1999. *LIMDEP version 7.0.* New York: Economic Software Inc.

Long, A. 1999. "Benefits of Prescribed Burning." Document # FR061 Gainesville, FL: Florida Cooperative Extension Service, University of Florida. http://edis.ifas.ufl.edu/FR061

Louviere, J.J. 1988. "Conjoint Analysis Modeling of Stated Preferences." *Journal of Transport Economics and Policy* 22 (1): 93-119.

Louviere, J. J. 1994. Conjoint Analysis. In: Bagozzi, R. (ed.) *Handbook of Marketing Research*. Oxford U.K.: Blackwell Publishers. pp. 223-259.

Matta and Alavalapati, (forthcoming). “Identifying and Prioritizing Forest Practices to Promote Biodiversity on Private Forests Applying the Analytic Hierarchy Process.”

McFadden, D. 1974. Conditional logit analysis of qualitative choice behavior. In: P. Zarembka (ed.) *Frontiers in Econometrics.* New York: Academic Press. pages 105-142.

Parkhurst, G.M., J.F.Shogren, C.Bastian, P.Kivi, J.Donner, and R.B.W. Smith. 2002. Agglomeration Bonus: an Incentive Mechanism to Reunite Fragmented Habitat for Biodiversity Conservation.” *Ecological Economics* 41 (2): 305-328.

FRA (2002). Southern Forest Resource Assessment. USDA Forest Service. http://www.srs.fs.usda.gov/sustain/report/index.htm

Shrestha, R.K., and J.R.R. Alavalapati. 2004. “Valuing Environmental Benefits of Silvopasture Practice: A Case Study of the Lake Okeechobee Watershed in Florida.” *Ecological Economics* 49: 349-359.

Shogren, J. F., J.Tschirhart, T.Anderson, A.W.Ando, S. R. Beissinger, D. Brookshire, G. M. Brown Jr, D.Coursey, R. Innes, S. M. Meyer, and P. Stephan .1999. “Why Economics Matters for Endangered Species Protection (in Essays).” *Conservation Biology* (13) 6: 1257-1261.

Concurrent Session 2C: Financial Economics

Timber Investment Returns for Plantations and Native Forests in South America and the Southern United States

Frederick Cubbage[1], Rafael Rubilar[2], Jacek Siry[3],
Patricio Mac Donagh[4], Mirta Noemi Báez[4],
José Sawinski Júnior[5], Arnaldo Ferreira[6], Vitor Hoeflich[7],
Virginia Morales Olmos[8], Gustavo Ferreira[8], Gustavo Balmelli[8],
José Alvarez[9], and Pablo Donoso[10]

Abstract

We estimated timber investment returns for the principal exotic and selected native plantation species in the Southern Cone of Latin America and in the Southern United States. Exotic eucalypts plantations in South America were most profitable, with internal rates of returns (IRRs) of about 13% to 24%, followed by exotic loblolly pine, with IRRs of about 9% to 17%. Average loblolly pine plantation returns in the U.S. South were less profitable, with an IRR of about 9.5%, and natural forest management in the South had IRRs of 4% to 8%. Subtropical native species plantations of the best aracauria and nothofagus species had reasonable financial returns, with IRRs ranging from 5% to 13%. Subtropical or tropical native forests had fewer commercial timber species, and had much lower growth rates and returns. Their IRRs were less than 4%, or even negative for unmanaged stands. State subsidy payments for forest plantations or for timber stand improvements increased IRRs about two to three percentage points and land expectation values (LEVs) about $300 to $500 per ha, but are less available and less useful for applications in natural stands, which have less initial investment costs. Reserving areas in plantations for environmental protection reduced their IRRs about one percentage point. Land costs decreased these internal rates of return substantially, from 4 to 10 percentage points. Thus the plantation investment returns were somewhat more comparable among all countries when the cost of purchasing land is included.

---

[1]North Carolina State University, Raleigh, NC, 27695-8008, USA; (919) 515-7789; fred_cubbage@ncsu.edu
[2]North Carolina State University, Forest Nutrition Cooperative
[3]University of Georgia, Athens, GA, USA
[4]Universidad Nacional de Argentina de Misiones, Eldorado, Misiones, Argentina
[5]Universidade de Contestado-Canoinhas, Canoinhas, Brazil
[6]CellFor, Atlanta, GA/Los Angeles, CA, USA
[7]Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) and Universidad Federal do Paraná, Curitiba, Brasil
[8]Instituto Nacional de Investigación Agropecuria (INIA), Tacuarembó, Uruguay
[9]CMPC Forestry, Concepción, Chile
[10]Universidad Austral de Chile, Valdivia, Chile

Introduction

Financial returns from planted and native forests are one of the most important factors driving forest management, conservation, and investments throughout the world. Periodic studies examine these returns for individual species or countries, especially for plantation species, but there is a relative scarcity of current public information about timber investment returns at the aggregate level. Some consulting studies examine these questions, but they do not provide widely disseminated knowledge or details of the inputs. Furthermore, there is a dearth of financial analyses of potential returns for natural tropical forests or native species plantations in the tropics or subtropics. Accordingly this study was initiated to provide better information about potential financial returns to exotic plantations and native forest investments in the subtropics and temperate forests in the Americas.

Methods

This study consisted of a cooperative research project conducted by the co-authors of this paper in various countries in the Americas. We selected the countries or regions of Argentina, Brazil, Chile, Uruguay, and the U.S. South because they are the most important areas in the Americas, and perhaps in the world, for production of industrial timber, and have the best prospects for increasing contributions to world trade in forest products in the future. The U.S. South produces about 15% of the industrial roundwood in the world (FAO 2003, Smith et al. 2004), and has 15.3 million ha of forest plantations. The four selected Latin American countries together produce about as much timber from plantations annually as the U.S. South now, and have a total of about 8 million ha of industrial wood plantations, out of 10.5 million ha of plantations in South and Central America. Average growth rates per year in those key South American countries are probably twice as large as forest plantations in the southern U.S. Prior research has confirmed these comparative growth rates and indicated that they do lead to greater rates of return in South America than in North America (Sedjo 2001, Tomberlin and Buongiorno 2001, IADB 2005).

Management Scenarios and Factor Costs

We worked as a group of scientists and tried to estimate the best possible typical scenario for the forests and country that we were familiar with. Species selected for analysis included loblolly pine (Pinus taeda) in Argentina, Brazil, and Uruguay, radiata pine (Pinus radiata) in Chile, and in eucalypts (E. globulus, E. grandis, and E. dunnii) in the countries where they are common. In addition, potential returns for native forest plantations or for natural forests were calculated for general species in the Latin America subtropics, for erva mate (Ilex paragurariensis) and aracauria (Aracauria angustifolia) in Brazil. We also examined an aracauria native stand in Argentina, as well as Nothofagus (N. dombeyi and N. nervosa) in Chile. Returns were calculated for planted and natural forests in the southern USA for comparison, including loblolly pine, longleaf pine (Pinus palustris), and natural hardwoods.

Table 1 summarizes the forest management scenarios we analyzed for plantations and native species and the average growth rates assumed. The typical management regimes for all forest species vary widely among and within countries, and evolve over time with changes in costs, prices, technology, and markets. There are not any standard forest management regimes for all species in each country. Plantation techniques vary by species, land quality, climate, timber markets, and capital, among other factors. We developed plantation management regimes for the species and countries selected, based on our experience and research summarized in Evans and Turnbull (2004), Rivero et al. (2004), Riegelhauppt and Burkart (2002), Uruguay Dirección Forestal (1995), and Lamprecht (1990). We used sensitivity analyses to examine the effects of higher prices and yields, land costs, environmental regulations, and government subsidies on investment returns.

Table 1. Forest Management Regimes for Selected Exotic Plantations and Native Forests in the Americas

Country	**Species**	**Rotation (year)**	**Thinnings and Harvests (years)**	**Growth (m^3/ha/yr)**	**Total Yield per Rotation (m^3)**
Argentina	Pinus taeda - Misiones	20	5, 8, 12, 20	30	600
	Pinus taeda - Corrientes	20	5, 8, 12, 20	35	700
	Eucalyptus grandis	14	5, 14	40	560
	Aracauria angustifolia	28	10,15,21,28	15	420
	Native forest unmanaged	80	20,40,60,80	1	20
	Native forest best management	80	20,40,60,80	2	60
Brazil	Pinus taeda	18	18	35	540
	Eucalypytus grandis	15	7,11,15	40	600
	Eucalyptus dunnii	7	7	43	301
	Aracauria angustifolia	25	10, 16, 21, 25	43	450
	Ilex paragurariensis	10	leaves, all	Na	na
Chile	Pinus radiata	22	7,11,15,22	22	484
	Nothofagus	30	10, 15, 22, 30	18	540

	dombeyi				
	Nothofagus nervosa	35	12, 18, 26, 35	16	560
Uruguay	Pinus taeda	22	11,15,22	20	440
	Eucalypts grandis	16	6,11,16	30	480
	Eucalypts globulus	10	10	18	180
Subtropical Optimal	Native forest optimal management	80	20,38,50,65,80	4	360
U.S.A.	Pinus taeda planted	30	17,24,30	12	360
	Pinus taeda natural	40	25,33,40	7.4	300
	Pinus palustris	80	38,50,65,80	4	320
	Hardwood sp.	80	38,50,65,80	4	320

Factor costs for planting and management were obtained for each country based on the authors' knowledge. Details on these costs are too lengthy for inclusion here, but may be obtained from the authors. Surprisingly, there seemed to be moderately similar total costs for initial plantation establishment in the Americas, ranging from $300 to $800 per ha, with a mean close to $500. This did vary by country, and would vary by intensity of management as well. We assumed a constant $20 per ha cost for management and administration costs for plantation species, and lowered this to $10 per ha for natural stand administration, since it should be less intensive. We used timber stumpage prices—"valor de madera en pie"—as the base for our timber investment calculations. We had relatively good information on average plantation timber or stumpage prices in Argentina, Brazil, Chile, and the United States. We assumed that for the base case in these analyses that landowners already owned the land, so it was a sunk or not relevant cost in the analysis.

Capital Budgeting and Sensitivity Analyses

We analyzed the returns to these timber investments using typical capital budgeting techniques and criteria, by the use of a spreadsheet. Capital budgeting criteria analyzed included net present value (NPV), land or soil expectation value (LEV, SEV, or the Faustman formula), internal rate of return (IRR), equivalent annual income (EAI), and benefit:cost ratio (B:C). We used Excel spreadsheets for each species/country combination, and developed the inputs independently as analysts for each country in most cases, or via interviews and revisions. We used an iterative process of developing each spreadsheet, reviewing the results with other experts in each country, comparing those with the results from other countries, and revising the typical case to be sure that we had representative scenarios.

We calculated the base financial returns for the species of interest at the selected growth rates, factor costs, and timber price returns. For this exercise, we also calculated several sensitivity analyses. These included (1) the withdrawal of some land from the plantable land area because of environmental restrictions, operating difficulties, or standard practices; (2) the inclusion of land costs as a factor of production; (3) the combination of (1) and (2); (4) the use of state subsidies for planting as available; and (5) the case of higher yields and prices. These sensitivity analyses were only applied to a few species with the greatest initial returns. Table 2 summarizes the assumptions for these sensitivity analyses.

Table 2. Assumptions for Sensitivity Analyses of Timber Investment Returns

Country/Species	Effective Plantable Area (%)	Timber Land Costs ($/Ha)	Subsidy Payments (% of cost)	Increased MAI (M^3/Ha/Yr)	Increased Sawtimber Prices (~%)
Brazil – P. taeda	60	2500	Na	40	10
Brazil – E. grandis	60	2500	Na	50	10
Uruguay – P. taeda	70	1000	39	30	25
Argentina – P. taeda	70	800	50	40	50
Chile – P. radiata	70	1500	50	30	10
U.S. South–P. taeda	70	1500	50	18	10

Results and Discussion

Base Case Financial Returns

These calculations found the approximate ordinal ranking one would expect regarding financial benefits (Table 3). Excluding land costs, exotic plantations in South America of Eucalyptus grandis and dunnii were most profitable with internal rates of return (IRRs) of more than 20%, followed by exotic loblolly and radiata pine, with IRRs of about 9% to 18%. Loblolly pine plantations in the U.S. South were less profitable, with about a 9.5% IRR, but comparable to P. taeda in Argentina and E. globulus in Uruguay. Native timber forest plantations of Aracauria and Nothofagus in South America had rates of return ranging from 5% to 13%. These rates of return were less than exotic plantations, but reasonable. These plantations also might grow on a broader range of sites than exotics. Erva mate for mate/tea had high rates of return and could be a good alternative for export and medium size producers, but market demand has not grown much in recent years, so prices could decrease if production increased much.

The variation in returns excluding the price of land does indicate that fast growth rates and reasonably good markets in Latin America do make their financial investment returns better. Brazil has the highest growth rates and the highest timber prices for exotic species at this time. Chile has good growth rates and good prices as well. Both have better prices because they have large and expanding timber markets, creating large demand for stumpage and wood delivered to their mills.

The results from Uruguay place it third in comparative timber investment returns of the four Southern Cone countries examined. While its timber investment returns excluding the price of land seem attractive, the market prices for stumpage or delivered wood are less certain. The Uruguayan plantation timber sector really just began in 1987 with the new national forestry law, so the timber markets are very thin now. New planned processing facilities will come on line, including two new pulp mills in Frey Bentos, two plywood/panel mills in Tacuarembó, and other plans. This new capacity should solidify local market expectations.

Table 3. Financial Returns to Exotic and Native Forest Plantations and Stands in the Americas by Capital Budgeting Criteria with a 8% Real Discount Rate, 2005

Country	**Species**	**Net Present Value ($/ha)**	**Land Expectation Value ($/ha)**	**Annual Equivalent Value ($/ha)**	**Benefit: Cost Ratio**	**Internal Rate of Return (%)**
Argentina	Pinus taeda - Misiones	1148	1462	117	1.73	12.9
	Pinus taeda - Corrientes	370	471	38	1.42	10.5
	E. grandis	819	1241	99	1.77	13.8
	Aracauria a.	-169	-215	-12	0.85	7.2
	Native forest unmanaged	-97	-19	-11	-22	<0
	Native forest best mgt.	-91	-111	-9	0.47	1.7
Brazil	Pinus taeda	1870	2495	200	3.25	16.0
	E. grandis	3716	5427	434	4.99	22.7
	E. dunnii	1196	2872	230	2.31	22.9
	Ilex p.	1061	1976	158	1.41	19.0
	Araucuria a.	823	963	77	1.96	12.4
Chile	Pinus radiata	2729	3345	268	3.57	16.9
	N. dombeyi	1581	2012	161	2.82	13.6
	N. nervosa	792	1009	81	1.91	10.9
Uruguay	Pinus taeda	1634	2003	160	2.90	15.1
	E. grandis	2890	4081	327	5.15	21.9
	E. globulus	319	593	47	1.49	12.8
Subtropical Optimal	Native species	-113	-138	-11	0.25	3.6
U.S.A.	Pinus taeda planted	333	408	33	1.39	9.5
	Pinus taeda natural	-25	-31	-2	0.94	7.8
	Pinus palustris	-413	-507	-41	0.16	4.3
	Hardwoods	-270	-331	-27	0.14	3.6

Argentina has excellent growth, technology, and well defined markets, but fairly low prices. This may be attributable to a lack of many large firms and a relatively large amount of fiber supply at the present. High risk premiums for borrowed capital and the long distance from the fertile timber-growing regions of Misiones and Corrientes to major international markets also may contribute to lower residual-value timber prices.

Timber investment returns excluding land prices in the U.S. are less than in Latin America, because growth rates are less, while the prices may be only slightly better than in Latin America. Typical returns for natural stand management in the temperate forests of the U.S. are not high, at about 4% per annum, but these returns are much better than typical returns for degraded natural stands in the subtropics, at about 2% per annum, or negative.

Sensitivity Analyses

The results of sensitivity analyses of the effects of land, timber growth and prices, and policy subsidies provide important perspective and balance on the comparative returns among countries (Table 4). The inherent advantages of fast growth rates and good timber prices for exotic species on existing forest land in Brazil and Chile give them tremendous advantages. However, like all economic activities, these high profits for forest investments have attracted more competition as well as capital, thus driving up the costs of the factors of production, especially land. Policy interventions—subsidies or regulations—also can make significant differences.

Table 4. Sensitivity Analyses of Timber Investment Returns with Land Costs and Subsidy Payments – Internal Rate of Return (%) and Land Expectation Value ($/ha, 8%)

Country/Species	Base without Land Costs	Base, Reduced Plantable Area	Base with Land Costs	Base with Land Costs, Reduced Area	Base with Subsidy Payments	Base with High Yields, Prices
Brazil – P. taeda	17.0 3095	16.1 1578	8.8 595	6.4 -922	Na	23.7 9704
Brazil – E. grandis	22.7 5427	21.7 2859	11.7 2927	7.7 -159	Na	27.5 9788
Uruguay – P. taeda	15.1 2003	14.5 1320	10.2 1003	8.9 320	17.3 2293	18.8 4514
Argentina – P. taeda – Misns.	12.9 1462	11.7 808	9.9 762	8.3 108	15.9 1958	19.8 4924
Chile – P. radiata	16.9 3345	16.1 2218	10.8 1845	9.3 718	23.5 3938	38.0 16605
U.S. South – P. taeda	9.5 408	9.2 241	5.9 1137	5.0 -1304	11.0 -702	12.3 1749

Reserves in Brazil did not have large adverse impacts of timber investment returns if one already owns the land—reducing IRRs from 17% to 16%. But they made net returns much worse if one must buy unproductive land and only get returns on the new plantations, reducing them to a 6% IRR. The reductions in IRRs for Eucalyptus grandis in Brazil are similar, but the IRRs remain greater than those for Pinus taeda.

Adding land cost to the Pinus radiata analyses in Chile reduced the net IRRs from 17% to 11%. Chile also has significant environmental laws and moderate enforcement. In net, these requirements may reduce the effective planted area out of the total area to about 70%, which does reduce net returns for existing land owners to about 16%.

Annual internal rates of return for Pinus taeda in Uruguay without land costs were 15%. With land costs, the net IRRs in Uruguay were 10%. Without land costs, but worth 70% net effective plantable area, the IRR was 14.5%. With both land costs and decreased area, the IRR was 8.9%. In Argentina without land costs, but with 70% net effective plantable area, the IRR was 11.7%. With both land costs and decreased area, the IRR is 8.3%. Without land costs, but with 70% net effective plantable area, the U.S. IRR was 9.2%, compared to 9.6% for the base case. With both land costs and decreased area, the IRR was 5.0%.

Conclusions

For existing owners, without land costs, timber investment returns for exotic timber plantations in Latin America are generally much greater than those for the native plantations of loblolly pine in the southern U.S. Brazil had the greatest investment returns generally, based on excellent growth rates and good prices for timber. Radiata pine in Chile had excellent returns as well, based on good growth rates and excellent timber prices. Uruguay has prospects of good investment returns as long as satisfactory markets and prices develop. Argentina has excellent growth rates but only moderate prices. Better markets and higher prices could enhance their returns. With fairly plentiful and cheap land in Misiones and northern Corrientes, Argentina offers attractive investment returns, especially if more wood processing capacity is added. Plantations in the U.S. have growth rates of about 1/3 to ½ of those exotic plantations in Latin America, which dampens investment returns despite relatively high prices.

Rates of return for native species plantations without land costs, in Latin America and in the U.S., were fairly similar, ranging from about 4% to 10%. The key to receiving good investment returns for native species was reasonable growth rates, of say at least 5 m^3 per ha per year. These rates of return are comparable to those of other capital assets, excluding land costs.

Subtropical native forest species in Latin America take longer to grow and have much lower growth rates and returns. Their internal rates of return for degraded stands were generally only 2% per year at best, and could be negative—that is they cost more for taxes and administration than they return on average. However, despite these low IRRs, the negative LEVs at 8% are small, since only small administrative costs are incurred.

The sensitivity analyses indicate that land costs, government subsidies, and reserve areas affect timber investments significantly. State subsidies generally could increase the rates of return about 2% to 3% when they were available, or the land expectation values about $300 to $500—the share of the establishment costs that was cost shared. Forest reserve areas decreased rates of return about 1%, excluding the costs of land. Brazil and Chile had the highest land costs and thus the greatest reductions in IRRs and LEVs, but the effects in all countries were substantial. IRRs decreased to 10% or less for all plantations when the land purchase costs were included. Uruguay fared best with land costs.

These calculations provide more specificity to the probable financial returns of exotic plantations, and merits of managing native species for timber investments. We calculated average returns for typical sites and conditions. However, the variation among sites, factor costs, growth rates, and timber prices could generate financial returns within species that were greater than the average returns among species. While our calculations of native species returns are preliminary, they do help explain pervasive problems in conservation of these forests. They do suggest that forest management can contribute to positive financial returns for native species, but those returns are likely to be much less than for plantations.

References

Evans, Julian and John Turnbull. 2004. Plantation Forestry in the Tropics, Third Edition. Oxford University Press. New York. 467 p.

FAO. 2003. State of the world's forests, 2003. Food and Agriculture Organization of the United Nations. Rome. 243 p.

IADB. 2005. Inversión directa en negocios forestales sostenibles. Banco Interamericano de Desarrollo. Accessed at: http://www.iadb.org/regions/re2/forestal/id/home-id.htm. 21 June 2005.

Lamprecht, Hans. 1990. Silvicultura en los Trópicos. Dutsche Geseltschaft fur Technische Zusummenarbeit (GTZ) GmbH Cooperación Técnica – República Federal de Alemania. Eschborn. 335 p.

Riegelhauppt, Enrique and Rodolfo Burkart. 2002. El uso madero sustentable de Selva Misionera. P. 73-90. In: La Selva Misionera: Opciones para su Conservación y Uso Sustentable. Fundación para Conservación de las Especies y Medioambiente. Buenos Aires, Argentina.

Rivero, L. N. Buffe, N. Pascaul, P. Mac Donagh, and T. Toma. 2004. Tree growth after selective harvesting in the Guarani Reserve, Misiones. In: 11th Technical Meeting, Forest and Environment. Eldorado, Misiones.

Sedjo, Roger A. 2001. The role of forest plantations in the world's future timber supply. The Forestry Chronicle 77(2):221-225.

Smith, W. Brad, Patrick D. Miles, John S. Vissage, and Scott A. Pugh. 2004. Forest Resources of the United States, 2002. General Technical Report NC-241. St. Paul, MN: USDA Forest Service North Central Forest Experiment Station. 137 p.

Tomberlin, David and Jospeh Buongiorno. 2001. Timber plantations, timber supply, and forest conservation. P. 85-94. In: World Forests, Markets, and Polices. Edited by Matti Palo, Jussi Uusivuori and Gerardo Mery. World Forests Volume III. Kluwer Academic Publishers. Dordrecht.

Uruguay Dirección Forestal. 1995. Uruguayan Forestry: Environmentally friendly and profitable—investment opportunities. República Oriental del Uruguay, Ministerio de Ganaderia Agricultura y Pesca, Dirección General de Recursos Naturales Renovables. 40 p.

Paper prepared based on Southern Forest Economics Workers Meeting (SOFEW); Baton Rouge, Louisiana; April 18-20, 2005.

Hurricanes and Timberland Investments

Jack Lutz[1]
Forest Research Group

[1] Forest Economist, Forest Research Group, 66 Old Stagecoach Road, Alton, ME 04468, (207) 827-1019, jlutz@forestresearchgroup.com

Hurricanes and Timberland Investments

Abstract

Hurricanes hit the Southeastern United States every year. Very strong hurricanes (e.g., Camille, Frederic, and Hugo) periodically cause major damage to timberland. There is a body of literature that examines the impacts of these hurricanes on timber. This literature typically discusses the amount and type of damage to trees and its impact on timber value, and salvage efforts and their impact on timber markets. While major hurricanes can cause significant damage, what is the likelihood that a timberland property will be struck by such a storm? We use GIS data to examine the strength and frequency of major hurricanes that have hit the South in the past 150 years.

Keywords: Hurricanes, Timberland, Investment

Introduction

Hurricane Camille hit the Gulf Coast in 1969 and caused significant damage to timber. Hurricane Frederic hit about the same area in 1979 and, again, caused significant damage to timber. Hurricane Katrina hit the same area in 2005. Days later, the focus of attention is on the destruction and human toll in the cities of New Orleans, Gulf Port and Biloxi, but it is highly likely that significant damage was done to timber. So how often do hurricanes hit the same place? Do you replace the destroyed stand only to have it hit again just before the new stand is ready to be cut?

Hurricane literature usually addresses two points: 1) what does the hurricane do to timber, and what is the best way to salvage whatever value is left, and 2) what does the volume of salvage timber do to timber markets immediately after the hurricane and over the long-term? (See, for example, Haight and Smith 1995, Nonnemacher 1970, Prestemon and Holmes 2000, and Sheffield and Thompson 1992.) Here we use GIS data to see how often hurricanes hit an area and how strong those hurricanes are. Our data are from the US Atlas (www. nationalatlas.gov) and include storms through 2003. They do not include such hurricanes as Ivan (2004) and Katrina (2005).

There are several factors that cause damage from hurricanes, but the major factor contributing to timber damage is wind. Hurricanes are classed according to wind speeds (Table 3) and winds associated with higher categories are very damaging. In addition, heavy rainfall leading to saturated soils can contribute to windthrow. A slower moving hurricane will inflict more damage than a faster moving hurricane of the same category, because it will drop more rain and subject trees to a longer period of wind.

Table 3.Saffir/Simpson Hurricane Scale

Category	Pressure (inches)	Winds	Surge (feet)	Damage
1	>28.91	74-95	4-5	Minimal
2	28.5-28.91	96-110	6-8	Moderate
3	27.91-28.47	111-130	9-12	Extensive
4	27.17-27.88	131-155	13-18	Extreme
5	<27.17	>155	>18	Catastrophic

So how bad must a hurricane be? The NOAA Hurricane Research Division classifies any storm of Category 3 or higher as a major hurricane, but smaller storms can inflict significant damage on forests. Note that the damage from Category 2 storms is "Moderate".

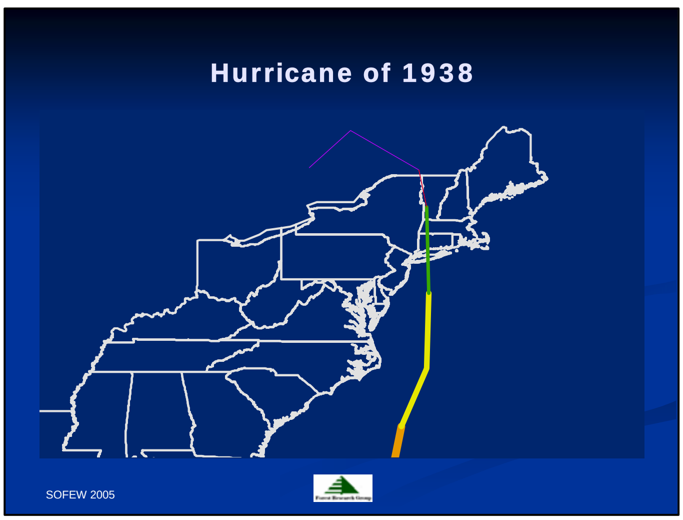
How strong a hurricane should we be worried about?

In the following illustrations, the storm categories are:

Red	Category 5
Orange	Category 4
Yellow	Category 3
Green	Category 2
Blue	Category 1
Purple	Tropical Storm
Dashed Purple	Extra-Tropical Storm or Tropical Depression

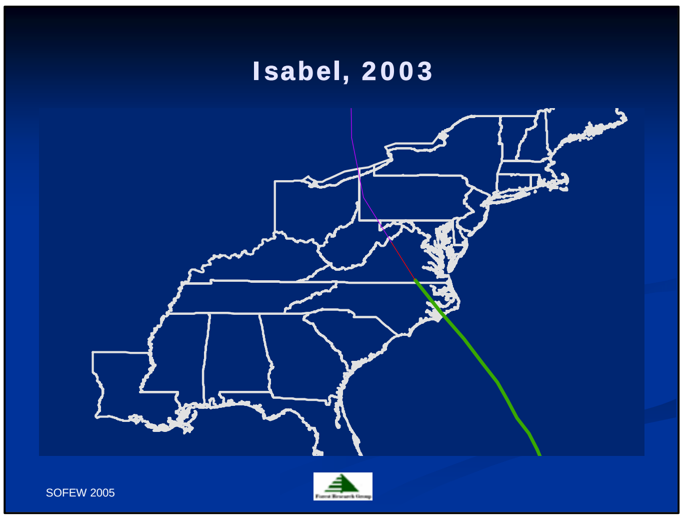
The ’38 hurricane in the Northeast (Figure 2) was classified as extratropical when it went ashore on Long Island and Connecticut, but the winds were clocked at 100 mph—equivalent to a Category 2 hurricane. Over a billion board feet of white pine were blown down.

Figure 2. Hurricane of 1938



Isabel (Figure 3) was a Category 2 hurricane when it came ashore in 2003. In North Carolina, 833,000 acres were damaged (Timber Processing 2003), including 25-75% of all trees on 410,000 acres. Damage was estimated at $565.9 million, including 3.9 million cords of pulpwood and 2.4 MMBF of sawtimber. By the time Isabel got to Virginia, it had been downgraded to a Category 1 storm. Approximately 10 million acres were affected in Virginia, with $176 million in damage to timber, mostly to old-growth pine stands and bottomland hardwoods.

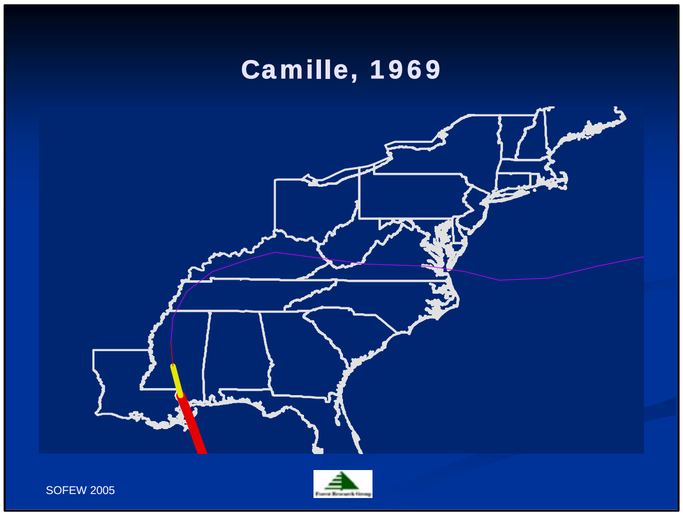
Figure 3. Hurricane Isabel



So Category 2 storms cause significant damage to timber, even though they are not classified as "major storms".

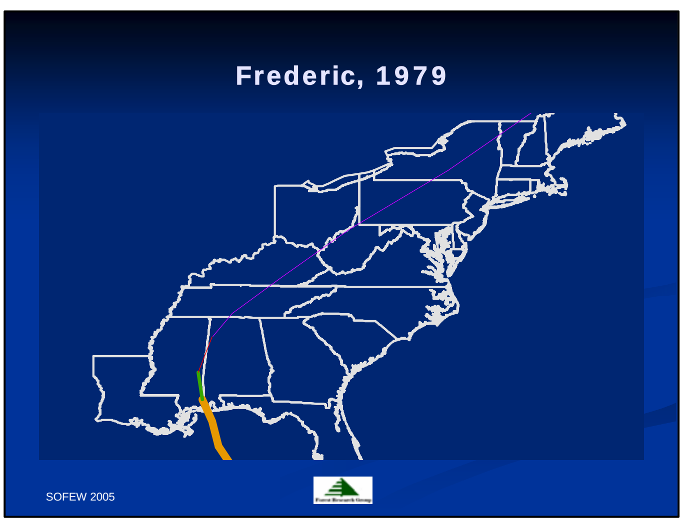
Camille (Figure 4) was a bad storm, the 11th most deadly, and the 5th most costly in US history through 2003 (Jarrell, Mayfield, and Rappaport, 2001). It came ashore as a Category 5, slowed to Category 3 by the time it hit Mississippi, then was a Category 1 storm for a short while.

Figure 4. Hurricane Camille



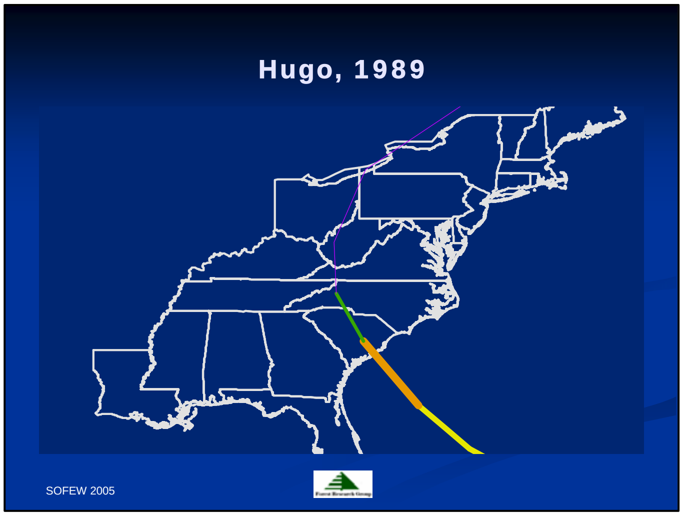
Frederic was also a bad storm for timber. It was the 7th most costly hurricane through 2003. Frederic came ashore as a Category 4 (Figure 5), slowed to Category 2, then Category 1 before leaving Mississippi

Figure 5. Hurricane Frederic



Hugo (Figure 6) first appeared as a Category 3 storm, then strengthened to Category 4 as it approached the coast. It is estimated to have damaged 20% of pine timber in the SC coastal plain.

Figure 6. Hurricane Hugo



The five storms above were some of the biggest timber-damaging storms. How often do such storms hit? How often do they strike the same area? Figure 7 shows all tracked storms since 1851. This is an impressive picture, but it includes Category 1 storms and tropical storms and depressions.

Figure 7. All Hurricanes, Tropical Storms and Tropical Depressions, 1851-2003

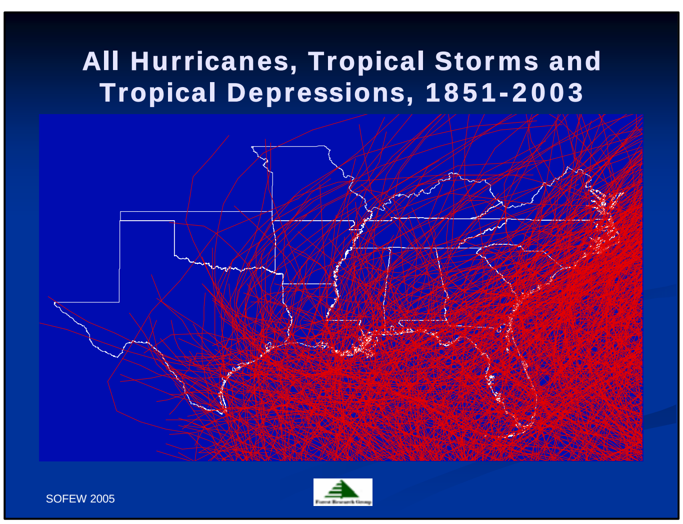


Figure 8 excludes the lesser storms and shows where Category 2 through 5 storms have hit between 1851 and 2003. It is clear from this figure that you must stay out of the coastal plain if you don't want your timberland to be hit by a hurricane. Georgia looks safe, except right along the coast. Virginia has had one Category 2 storm run along the coast, another (Isabel) turned to a Category 1 just as it reached the border, and a Category 3 dropped to Category 1 at the border. The South Carolina coastal plain has been a repeated target. There is hardly a part of Florida that has not been hit.

Figure 8. All Category 2-5 Hurricanes, 1851-2003

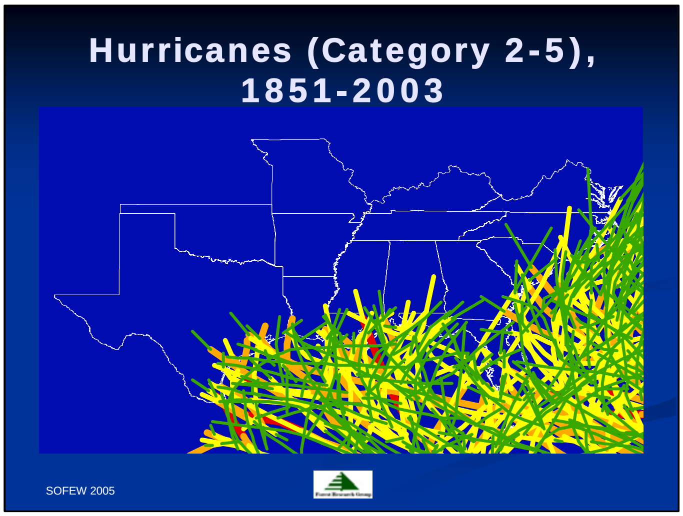


Table 4 shows the frequency of Category 2 through 5 storms hitting southern states. All states except Virginia have had more than one of these storms hit in a single year. All states except Florida have had up to 24 years between such storms—which means it is possible to go through a single rotation without a plantation being hit by a Category 2 or stronger hurricane. However, the *average* time between these storms is 3-17 years, which means it is *unlikely* that any given stand will go through a rotation without being hit.

Table 4. Category 2-5 Hurricane Frequencies for Southern States

State	Total 1851-2003	Average Years Between	Standard Deviation	Maximum Years Between	Minimum Years Between
VA	9	16.9	11.9	37	1
NC	38	4.0	5.6	25	0
SC	19	7.8	10.0	36	0
FL-north	43	3.3	3.7	17	0
GA	25	5.4	7.8	29	0
AL	22	6.7	10.4	49	0
MS	19	7.7	9.2	39	0
LA	39	3.9	4.4	24	0
TX-east	16	8.3	6.6	26	0

Conclusion

Timber damage can be significant from hurricanes that are Category 2 or stronger. The US coastal plain is subject to these hurricanes on a regular basis. The piedmont and mountains are almost never subjected to storms of this strength. Forest managers on the coastal plain must allow for hurricane damage in their management and operation plans.

Literature Cited

Haight, R.G., and W.D. Smith, 1995, Hurricanes and the Economics of Loblolly Pine Plantations, Forest Science, 41(4):675-688

Jarrell, J.D., M. Mayfield, and E.N. Rappaport, 2001, The Deadliest, Costliest and Most Intense United States Hurricanes from 1900 to 2000, NOAA Technical Memorandum NWS TPC-1,

Nonnemacher, R.M., 1970, Storm and the Forester, Journal of Forestry, pp. 712-714

Prestemon, J.P., and T.P. Holmes, 2000, Timber Price Dynamics Following a Natural Catastrophe, American Journal of Agricultural Economics, 2000(2):145-160

Sheffield, R.M., and M.T. Thompson, 1992, Hurricane Hugo Effects on South Carolina's Forest Resource, SE Forest Experiment Station, Resource Paper SE-284

Timber Processing, 2003, Effects of Isabel Will Be Felt, p. 6

Concurrent Session 3A: Economics of the Forest Products Industry

Are We Transitioning from an Era of Oak to an Era of Maple?

William G. Luppold[1]
and
Matthew S. Bumgardner[2]
USDA Forest Service

[1] Project Leader, USDA Forest Service, Northeastern Research Station, 241 Mercer Springs Road, Princeton, WV 24740. email wluppold@fs.fed.us 304.431.2770 (v): 304.431.2772 (fax)

[2] Forest Products Technologist, USDA Forest Service, Northeastern Research Station, 241 Mercer Springs Road, Princeton, WV 24740. email mbumgardner@fs.fed.us 740.368.0059 (v): 740.368.0152 (fax)

Are We Transitioning from an Era of Oak to an Era of Maple?

Abstract --Oaks and maples encompass numerous species that are processed into hardwood lumber and sold under four broad categories: red oak, white oak, hard maple, and soft maple. Historically, the most valuable lumber produced from these species has been used in the production of furniture, millwork, cabinetry, and flooring, as well as exported. However, over the last 40 years, relative prices of these species have fluctuated as demand (driven by fashion considerations) and relative availability have changed. In the mid-1960s, maples were important appearance species and along with black cherry dominated the furniture markets. From 1973 to 1990, the price of oaks increased as white oak was in high demand in export markets and red oak was used heavily in the production of furniture and kitchen cabinets for domestic markets. During the same period, the price of hard and soft maple declined. During the 1990s, the use of maple species for kitchen cabinet and furniture production increased while the use of white oak declined and red oak use remained steady. Maple used in appearance applications has continued to increase. By January 2005, prices of mid-and higher quality hard and soft maple lumber surged past those for red and white oak lumber. We examine the historical use of these economically important species and link the changing price of these species groups to fashion trends and relative availability.

Key words – Hardwood lumber, price, oak, maple

Introduction

Oaks and maples encompass numerous species that are processed into hardwood lumber and sold under four broad categories: red oak, white oak, hard maple, and soft maple. These species have different visual characteristics and changing consumer preferences have contributed to divergent trends in lumber prices over the last 40 years. During the 1960s, maples were the higher priced species group and preferred in furniture manufacturing. During the 1970s and 1980s, the preference for oaks increased along with oak prices. Since the mid-1990s, deflated prices for higher grade maple lumber have increased steadily, while the prices of higher grade oak lumber have trended downward. Have we ended an era in which the oaks were highly valued and begun an era in which maples will again be a high-priced species? We address this question by examining species preferences, physical availability, and prices for mid-grade (No. 1 Common or 1C), high-grade (Firsts and Seconds or FAS), and lower grade (No. 2 Common or 2A) oak and maple lumber from 1965 to 2005.

Species Preference

Preferences for hardwood species are influenced by function and fashion considerations. Functional preferences usually are dictated by specific wood properties or by tradition. For instance, many white oak species are used in the production of whiskey barrels or other tight cooperage products because the pores of most white oak species are plugged with tyloses. Hard maple has traditionally been used for basketball floors and was used heavily in the production of bowling alleys until the advent of substitute products.

Preferences resulting from functional considerations are an important part of overall species demand, but changes in species preference as dictated by fashion probably are the greatest source of price variability in hardwood lumber. Two indicators of fashion and wood preference are species shown for bedroom and dining room suites at the High Point Furniture Market (Table 1), and species displayed in cabinets exhibited at the International Builder Show and Kitchen & Bath Industry Show. The wood furniture and kitchen cabinet industries are the largest users of 1C lumber but also use FAS and 2C lumber. Percentages of showing do not translate directly into wood demanded by these industries, but they do provide a barometer of species fashion.

Percentages of furniture suites featuring major hardwood species shown between 1966 and 2005 are listed in Table 1. In 1966, less than 6% of the furniture suites shown were oak compared to 20% maple and 15% cherry. We mention cherry because maple lumber can be combined with cherry veneer and marketed as cherry furniture. As oaks became more popular, the popularity of maple decreased; by 1986 only 2.5% of the suites shown featured maple. In 1990, the number of oak suites shown peaked at 30% while the number of maple and cherry suites shown also increased (Frye 1996). Since 1990, the oaks have declined in popularity as the percentage of suites featuring maple or cherry have increased. However, even with the resurgence of maple in recent years, the percentage of suites featuring maple have yet to approach the levels of the late 1960s as alternative species such as red alder, birch, and rubberwood have been introduced.

Table 1 – Percentage of dining room suites that featured major hardwood species at the High Point (NC) Furniture Market, 1966 to 2005.[a]

Year	Oak	Maple	Cherry	Walnut	Pecan	Mahogany
	-----------------------------------percent-------------------------------------					
1966[b]	5.5	20.0	15.0	21.0	NA	6.0
1970[b]	14.0	12.0	10.0	15.5	14.0	2.5
1974[b]	11.5	9.0	3.5	8.0	8.0	2.0
1978[b]	19.0	8.0	6.0	4.5	12.0	3.0
1982[b]	25.5	6.0	10.5	2.5	7.5	4.5
1986[b]	21.0	2.5	12.0	2.5	5.0	6.0
1990[b]	30.0	4.5	15.0	2.0	4.0	7.5
1994[b]	27.5	7.0	16.5	1.0	1.0	7.0
1998[c]	20.0	6.2	21.0	1.0	1.0	7.0
2002[d]	17.0	9.0	20.0	2.0	0.5	6.0
2005[e]	15.0	9.0	15.0	2.0	1.0	5.0

[a] Percentages do not add to 100 because other species were featured e.g., pine, ash, rubberwood, alder, yellow-poplar, birch, beech, primavera, and other domestic and imported species for which historical data are incomplete.
[b] Source: Frye 1996.
[c] Source: Woods Unlimited News, 1988, Zionsville, IN.
[d] Source: Appalachian Hardwood Manufacturers Inc., 2002, High Point, NC.
[e] Source: Appalachian Hardwood Manufacturers Inc., 2005, High Point, NC.

The wood furniture industry was once the single most important market for hardwood lumber. However, because of the growth in the kitchen cabinet industry and the decline in domestic furniture production due to increased imports from China and other sources, overall demand for lumber by these industries was nearly equal in 2004 (Hardwood Mark. Rep. 2005).[2] In 1989, more than 55% of kitchen cabinets on display at the International Builder Show and Kitchen & Bath Industry Show were oak while less than 5% were maple (Hardwood Mark. Rep. 2005). By 1995, this ratio changed to 40% oak and 30% maple. As a fashion species in this industry oak continued to decline such that by 2004, it accounted for less than 10% of the showing compared to more than 40% for maple.

A major user of FAS lumber is millwork and a major use of hardwood millwork is commercial construction e.g. restaurants, shopping malls, retail stores, common areas of hotels, and lobbies and executive suites of office buildings. There are no published indicators of species use in commercial construction, but the oaks apparently were fashionable in the 1970s and 1980s while maple and other closed-grained species become more fashionable in the 1990s and beyond.

[2] Data do not differentiate between red and white oak or hard and soft maple because statistics were not collected consistently for individual species groups.

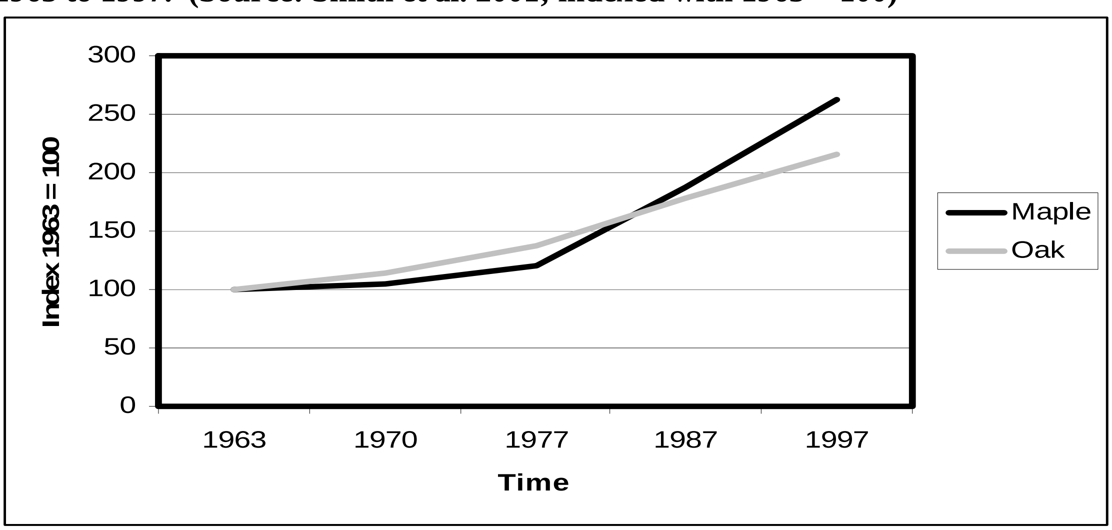
Solid strip flooring is one appearance application for oak that has grown considerably since the mid-1980s. Since 1989, production of oak flooring has increased by 300% (Emanuel and Rhodes 2002, 2005). Although red oak is preferred over white oak for flooring, that this industry consumes considerable amounts of 2C lumber in both red and white oak.

The last major market for appearance hardwood lumber is exports which has incased more than tenfold since the early 1970s. During the 1970s and 1980s the United Sates exported large quantities of FAS white oak to Europe and Japan. Mid- and lower-grade exports of red oak began to increase in the mid-1980s with the development of the Taiwanese furniture industry. It is interesting that red oak declined from 25% to 10% of the total hardwood lumber volume exported to Asia from 1994 to 2004, according to United States bureau of the Census. This is likely a function of the decreasing popularity of red oak in the United States, the final destination for much of the furniture manufactured in Asia. Oaks still account for 40% of overall United States hardwood lumber exports but maples now comprise 19%.

Availability Issues

Although the influence of species preference on demand affects interspecies hardwood lumber prices, the inventory levels of a species can influence timber prices and affect lumber price through supply. Whereas oaks are distributed widely and accounted for 39% of the eastern sawtimber inventory, maples make up only 13% of the eastern sawtimber resource and are more abundant in the northern United States. Inventories of white oak increased at a fairly constant rate over the last 50 years; maple inventories increased at a much lower rate from 1963 to 1977 but have increased at a much higher rate since 1977 (Fig. 1). From 1985 to 2003, the maple market share of hardwood lumber production has increased from nearly 9% to more than 13%, while the market share of oak has fluctuated between 48% and 50% (U.S. Dep. Commer. Bur. Census 1986, 2004).

Figure 1. Relative growth of United States maple and oak sawtimber inventories, 1963 to 1997. (Source: Smith et al. 2001; indexed with 1963 = 100)



Changes in Deflated Price

Deflated average yearly prices for grades FAS, 1C, and 2C red oak, white oak, hard maple, and soft maple are presented in Figures 2-5, respectively. By focusing on FAS prices for these species groups, we can discern two periods of different price movements that are related to the changes in species preferences discussed above. Between the mid-1960s and the mid-1980s, the prices for FAS red and white oak increased as the prices for FAS hard and soft maple decreased. After the mid-1980s oak, prices remained relatively flat while maple prices escalated.

To examine these differences in price trends, we estimated annual rates of change for the different lumber grades and species groups. We decided to separate the data set into two groups of similar size: 1965 to 1985 and 1986 to 2005. Although the prices for 2005 do not reflect the entire year, there was a considerable decline in oak prices and a considerable increase in maple prices during the first 3 months. The separation point of 1985 was chosen because 1965 and 1985 represent similar production peaks in the hardwood production cycle.

Annual change in deflated hardwood lumber prices for the grades and species examined were calculated by estimating the natural logarithm of price as a function of time and allowing both the intercept and slope to shift between the two periods. The specific equation estimated was:

$$\mathrm{Ln}\,(P_{ij}) = B_{0ij} + B_{1ij} + B_{Fij}\,(T_F) + B_{Sij}\,(T_S)$$

where

$\mathrm{Ln}\,(P_{ij})$ = Natural logarithm of price for species i of grade j
B_{0ij} = Intercept for species i of grade j
B_{1ij} = Intercept shifter for species i of grade j during second period (1986-2005)
B_{Fij} = Slope for species i of grade j during first period (1965-1985)
T_F = Sequential time variable for first period (1 to 21 for 1965-1985, 0 otherwise)
B_{Sij} = Slope for species i of grade j during second period
T_S = Sequential time variable for second period (1 to 20 for 1986-2005, 0 otherwise)

Annual change in real price for the two periods ($AC_{F,}$ and AC_S) was calculated using the procedure described in deSteiguer et al. (1989):

$$AC_{F \text{ or } S} = (\{\text{antilog of corresponding slope coefficients } (B_{Fij} \text{ or } B_{Sij})\}-1)$$

Estimates for $AC_{F,}$ and AC_S for each grade and species, the goodness of fit (R^2) for each equation, and the t value associated with the respective B_{Fij} and B_{Sij} coefficients are presented in Table 2. The R^2 associated with the individual price trend equations generally was high except for the price of FAS and 1C white oak and 2C soft maple. The R^2 associated with the price of FAS white oak was diminished by the large increase in both exports and price in the early 1980s due to a precipitous drop in the value of the United States dollar. The deflated price of 1C white oak has been nearly constant over the entire period, resulting in a low R^2. The deflated price of 2C soft maple has been highly variable since 1985. As a result the R^2 is low even though the B_{Fij} and B_{Sij} coefficients were statistically significant.

Table 2 -- Goodness of fit (R^2), calculated percentage annual rate changes (%AC), and Student "t" statistics of associated regression coefficients of time (t value) for inflation adjusted prices of lumber grades FAS, No. 1 Common, and No. 2 Common Appalachian red oak, white oak, hard maple, and soft maple lumber from 1965 to 1985 and 1985 to 2004.

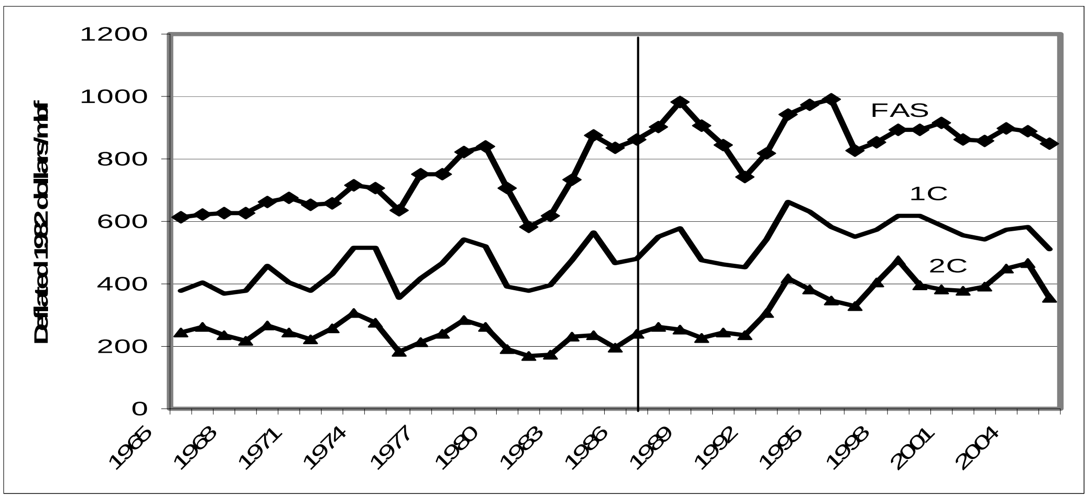
Species group Grade	$R^{2\,a}$	1965 to 1985 AC_F [b]	 t value [c]	1986 to 2005 AC_S [b]	 t value
Red oak					
FAS	.71	1.12	3.60[d]	-0.03	0.10
No. 1 Common	.60	1.02	2.42[e]	0.70	1.56
No. 2 Common	.76	-1.12	2.16[e]	3.55	6.23[d]
White oak					
FAS	.33	1.34	3.16[d]	-0.92	2.05[e,f]
No. 1 Common	.09	0.46	0.99	0.32	0.65
No. 2 Common	.46	-0.45	0.87	2.11	3.72[d]
Hard maple					
FAS	.88	-2.90	8.11[d]	4.76	11.89[d]
No. 1 Common	.88	-2.46	7.05[d]	5.23	13.43[d]
No. 2 Common	.70	0.37	0.77	3.54	6.78[d]
Soft maple					
FAS	.91	-3.32	11.22[d]	4.82	14.54[d]
No. 1 Common	.75	-2.84	8.31[d]	2.40	6.36[d]
No. 2 Common	.31	-1.42	2.95[d,f]	1.16	2.21[e]

[a] R^2 value is for the equation from 1965 to 2005.
[b] AC denotes annual rate of change (percent) for first (AC_F) and second (AC_S) periods.
[c] t value is for the coefficient from which annual rate of change was developed
[d] Significant at .01 level.
[e] Significant at .05 level.
[f] Preliminary analysis indicates coefficients not statistically significant following adjustment for autocorrelation.

Since a cyclical time series was being examined, the presence of autocorrelation was possible. Durbin-Watson statistics developed for each price equation indicated serial correlation in all models except for 1C red oak. Preliminary attempts to adjust for serial correlation produced ambiguous results depending on the length of the autocorrelative lag structure. Coefficients representing the second-period price of FAS white oak and first-period price of 2C soft maple were not statistically significant after adjustment.

The price of FAS and 1C red oak increased in real terms between 1965 and 1985 while the price of low-grade red oak lumber decreased during this period (Figure 2). These trends indicate activity in two separate markets. FAS and 1C red oak were being used in the production of millwork and furniture, while the major market for 2C red oak i.e., flooring, was in decline. From 1986 to 2004, there was no significant growth or decline in the prices of FAS or 1C red oak but a relatively large increase in the price of 2C red oak. Again, this reflects the stable or declining preference for red oak in furniture, millwork, and kitchen cabinets, and the large increase in demand for flooring. There has been no formal analysis of the decline in oak preference. The industry consensus is that today's consumers tend to dislike the grain pattern associated with oak, specifically color variations associated with red oak.[3] This rejection of red oak as an appearance species may be surprising to some but red oaks always have been considered less desirable than white oak (Wray 1952).

Figure 2 – Yearly prices of deflated FAS, 1C, and 2C Appalachian red oak lumber form 1965 to 1985 and 1986 to 2005. (Source: Hardwood Market Report, Memphis, TN; deflated by U.S. Department of Labor producer price index)

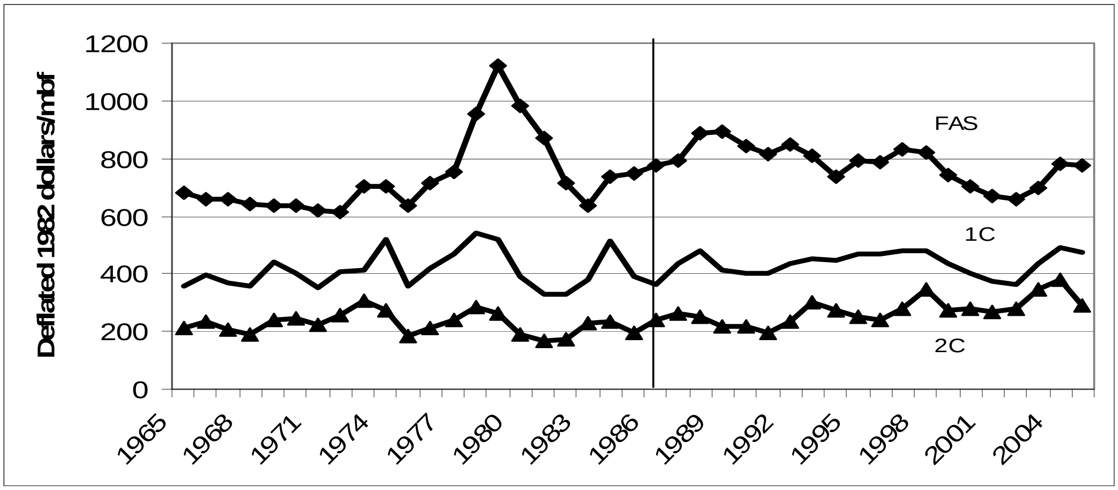


The increase in FAS white oak prices between 1965 and 1985 is strongly related to the export of this lumber to northern Europe and Japan (Figure 3). The decline in FAS prices after 1985 is a reflection of reduced export demand. Although white oak is used in furniture production, the preference for red oak might account for the lack of significant change in the price of 1C white oak. The price of 2C white oak showed no significant change between 1965 and 1985, though white oak also is used in the production of flooring. However, the lower growth rate of 2C white oak versus red oak since 1985 reflects a preference for red oak for flooring.

[3] Based on conversations in first quarter 2005 with Mark Barford, Executive Vice President, Appalachian Hardwood Manufacturers Inc, High Point, N.C.

The prices in Figure 3 reflect white oak prices in the United States market. European and Japanese consumers have continually paid higher prices for FAS and 1C white oak but require separations for color, ring count, heartwood content, length, and width.[4] One can argue that white oak with more desirable growth attributes (color, ring count, ring consistency) has been continually pulled from the domestic market by international buyers. These attributes do not influence grade but they do affect price.

Figure 3 – Yearly prices of deflated FAS, 1C, and 2C Appalachian white oak lumber form 1965 to 1985 and 1986 to 2005. (Source: Hardwood Market Report, Memphis, TN; deflated by U.S. Department of Labor producer price index)



Between 1965 and 1985 prices, for FAS and 1C hard maple declined by 2.9 and 2.5% per year, respectively (Figure 4). Since 1985, prices of all grades of hard maple have increased. The use of 2C hard maple in basketball floors and bowling alleys might account for the stable price of this grade from 1965 to 1985. Since 1985, 2C maple also has been used by manufacturers of kitchen cabinets.

Although the price increases for hard maple since 1985 are spectacular, the true extent of this growth is muted because Figure 4 does not reflect the development of a separate market for "white" hard maple during the mid-1990s. Historically premiums have been paid for white hard maple but white maple now is quoted separately due to increased demand. White maple is sapwood that has not been discolored by improper handling of logs or lumber. In March 2005, prices for FAS, 1C, and 2C white hard maple were 32%, 19%, and 44% higher, respectively, than those for color unselect hard maple.

The decline and rise of soft maple prices during the two periods were similar to the movement of hard maple prices (Figure 5). However, since 2C soft maple had no specialty market like basketball courts or residential flooring, it showed the greatest decline in 2C lumber from 1965 to 1985. This lack of a specialty market might have accounted for the low rate of growth for 2C soft maple since 1986.

---

[4] Based on conversations in first quarter 2005 with Edward Ramsey, Taylor Ramsey Lumber Co., Lynchburg, VA.

Figure 4 – Yearly prices of deflated FAS, 1C, and 2C Appalachian hard maple lumber form 1965 to 1985 and 1986 to 2005. (Source: Hardwood Market Report, Memphis, TN; deflated by U.S. Department of Labor producer price index)

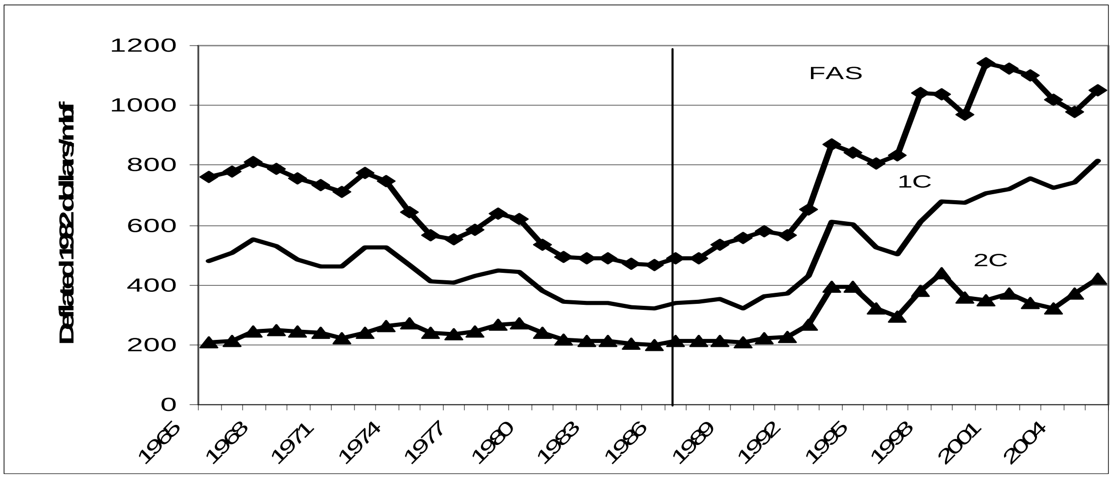
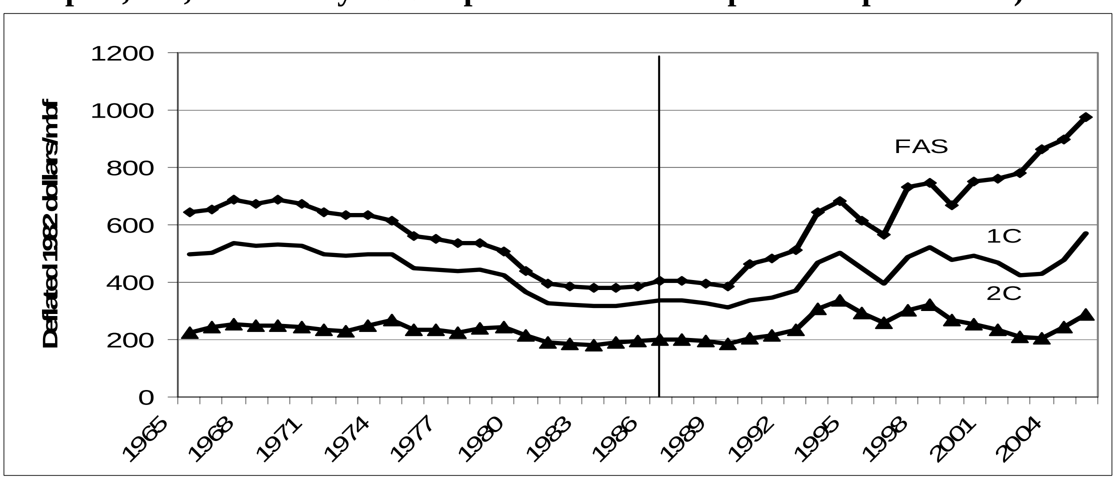


Figure 5 – Yearly prices of deflated FAS, 1C, and 2C Appalachian soft maple lumber form 1965 to 1985 and 1986 to 2005. (Source: Hardwood Market Report, Memphis, TN; deflated by U.S. Department of Labor producer price index)



Examination of the estimated rate of annual change (Table 2) revealed considerably greater change in the prices of FAS and 1C hard and soft maple than in prices for red and white oak for the two periods The large declines in maple prices between 1965 and 1985 correspond to large declines in the preference for these species (Table 1). The large increase in price since 1985 may have been influenced by the lower sawtimber inventories of these species that caused supply to be more inelastic.

Conclusion

The accession of oak (especially red oak) as the dominant appearance species during the 1970s and 1980s was a major shift in the hardwood market. A search of records prior to 1970 found no reference to red oak as a high-value species; if anything, red oak was held in low regard (Wray 1952). By contrast, maples have been used by furniture manufacturers from colonial times but the growth in maple inventory apparently was insufficient to satisfy demands without additional price increases during the late 1960s. The shift from maple to oak may have been related more to perceived availability of oak by furniture manufacturers than to changes in preferences by the final consumer. Still, once consumers accepted oak, the value of these species increased even though inventories were abundant.

The shift from oak to maple that began in the late 1980s also could have been triggered by the relative low price of maple versus oak. This caused furniture and kitchen cabinet producers to show maple to potential customers. Now that consumers have accepted maple, there again seems to be a negative connotation associated with oak. In a 2005 editorial published in the Weekly Hardwood Review, the term "anything but oak" seemed to reflect the sentiments of many furniture, cabinet, and millwork consumers. However, consumers may not be able to afford a preference for maple in the long run.

Although long-term growth trends suggest an increasing supply of maples relative to oaks, the supply of maple will be much smaller than that of oak sawtimber for the foreseeable future. Also, the white maple that commands the highest prices in the market is in shorter supply than color unselect maple. As a result maple prices are expected to continue to increase to a point where consumers must include price in the purchasing equation. This could expand opportunities for maple substitute species, both domestic and foreign. It is interesting that the popularity of maple in the marketplace apparently is not associated with consumers' ability to identify maple wood (Bowe and Bumgardner 2004). Development of new finishes for oak that are more acceptable to today's consumer could help oak regain greater acceptance. Should this occur, one can expect greater separations for visual characteristics such as grain and color to placate the aesthetic concerns of consumers.

Literature Cited

Bowe, S. and M. Bumgardner. 2004. Species selection in secondary wood products: perspectives from different consumers. Wood and Fib. Sci. 36(3):319-328.

de Steiguer, J.E., L.W. Hayden, D.L. Holley Jr., W.G. Luppold, W.G. Martin, D.H. Newman, and R.M. Sheffield. 1989. Southern Appalachian timber study. USDA For. Serv. Gen. Tech. Rep. SE-56. 45 p.

Emanuel, D. and C. Rhodes. 2002. Bulletin of hardwood market statistics: 1989-2000. USDA For. Serv. Res. Note NE-375. 22 p.

Emanuel, D. and C. Rhodes. 2005. Bulletin of hardwood market statistics: first half 2004. USDA For. Serv Res. Note NE-384. 22 p.

Frye, L.R. 1996. The most popular furniture woods: the historical perspective. Wood and Wood Prod. Centen 1896-1996. 100(14):304-307.

Hardwood Market Report. 2005. 2004: The year at a glance. Hardwood Market Report, Memphis, TN. 130 p.

Smith, W.B., J.S. Vissage, D.R. Darr, and R.M. Sheffield. 2001. Forest resources of the United States, 1997. USDA For. Serv., North Cen. Res. Stn. Gen. Tech. Rep. NC-219. 190 p.

U.S. Department of Commerce, Bureau of the Census. 1986. Lumber production and mill stocks 2000. MA24T(85)-1. U.S. Dep. Commer., Bur. Census, Washington.

U.S. Department of Commerce Bureau of the Census. 2004. Lumber production and mill stocks 2003. MA321(03)-1. U.S. Dep. Commer., Bur. Census, Washington.

Wray, R.D. 1952. Forest statistics for West Virginia. WV No.1. USDA For. Serv., Northeast. For. Exp. Stn., Upper Darby, PA. 48 p.

Concurrent Session 3B: Regional Economics

Economic Impact of the Wood Industry in Northwest Pennsylvania[1]

Bruce E. Lord,[2] Charles H. Strauss, and Michael J. Powell
School of Forest Resources
The Pennsylvania State University

[1] This project was supported by the Pennsylvania Hardwood Development Council - Contract ME 443050.
[2] Senior Research Assistant, School of Forest Resources, The Pennsylvania State University. 206 Ferguson Bldg. University Park, PA, 16802. bel@psu.edu. (814) 865-7554

Economic Impact of the Wood Industry in Northwest Pennsylvania

Abstract

The impact of the wood industry within a 14-county northwest region of Pennsylvania was determined for 2003. Two-thirds of the region is forested, with 4.7 million acres commercially classified as timberland. The wood industry contributed 4% to regional output ($2.0 billion) and supported 2% of the region's employment (7,960 jobs). The sawmill sector had $661 million of output and 2,369 employees. Other key sectors were paper, board, and fiber - $485 million in output and 636 jobs and secondary wood manufacture - $472 million and 3,624 jobs. The total economic impacts generated by the region's wood industry were $2.7 billion in output and 17 thousand jobs with wages and salaries of $0.43 billion. Key regional industries that benefited from the wood industry were Agriculture ($231 million revenues), Services ($159 million), Transportation, Communications and Public Utilities ($147 million), Trade ($144 million), and Finance, Insurance, and Real Estate ($111 million). Of the 372 million board feet (mmbf) of logs consumed by regional mills, only 22 mmbf originated from regional public lands. The majority (308 mmbf) came from private lands, with an additional 41 mmbf purchased from outside the 14-county region.

Key words: AHUG, sawmilling, timber supply, hardwoods.

Economic Impact of the Wood Industry in Northwest Pennsylvania

Introduction

Pennsylvania's wood industry is both a symbol of its past and a major contributor to its present day economy - particularly within rural regions. Underlying the industry's persistence and strength, are the forests of Pennsylvania. This is a proven resource base, covering 60% of the state and including some of the most valuable timber in the world (Steer 1948, Powell and Considine 1982, Alerich 1993, McWilliams 2003). Future projections of timber supplies have been quite promising (Strauss and McWilliams 1987, Strauss and Lord 1989, Strauss 1990, McWilliams et al. 2003).

The transition of this industry led to its expanded economic role within rural regions (Westman et al. 1985, Strauss et al. 2000). As a result, business leaders and public officials are now placing renewed attention on this manufacturing group. However, questions still remain regarding the direction of hardwood manufacture and the future availability of timber supplies. Economic impact analysis provides a functional insight on the overall contributions of an industry and its commercial linkages to other regional industries (Alward et al. 1985). Earlier efforts by Strauss et al. (1991, 2000) have assessed the economic impact of the hardwood industry within rural communities and their potential for added foreign trade.

This project examines the impacts of the wood industry within the 14-county Allegheny Hardwood Utilization Group (AHUG) region. The AHUG region is the home of the Allegheny National Forest, several State Forests, and contains important inventories of highly valuable Black Cherry (*Prunus serotina* Ehrh.). This effort further analyzes the wood industry's relative economic strength in the region's economy. As a final component, the most recent timber supply analysis for the region (McWilliams et al. 2003) will be examined in light of the current demands of this industry in order to project the degree of balance between growth and harvest of this timber resource and the probable direction of wood product manufacture in the AHUG region.

Objectives

This study identifies the economic structure of the various hardwood production sectors of the 14-county Allegheny Hardwood Utilization Group region. The total sales, value added, employment, and timber inputs of the region's wood industries will be established. This industries' contribution to the total regional economy will be highlighted. The demands of this industry on the timber resource will be contrasted to the supply of raw materials to determine the future potential of these industrial sectors. Specifically:

1. Develop regional profiles of the sectors within the wood industry including timber

inputs, sales, and employment. Timber will be further identified on the basis of ownerships and key species groups.

2. Determine the direct, indirect, and induced employment and income impacts of the wood industry group within the 14-county AHUG region.

3. Evaluate the relative economic role of the wood industry within the 14-county AHUG region as compared to the overall regional economy and to other lead production sectors within the region.

4. Counter compare the current and projected timber demands of the wood industry to the most recent timber supply information currently available from the U. S. Forest Service (McWilliams et al. 2003). This effort will pay particular attention to comparisons of timber harvest and forest growth by type of ownership.

Procedures

Objective 1

The economic profile of the wood industry was largely developed through a direct survey of representative companies within this industry. The target sample frame included all sawmills operating over 5 MMBF annually, all secondary manufacturers employing over 50 persons, and a 20 to 40% sample of the smaller scale operations.

Objective 2

The economic impact of the wood industry was generated through the Impact Analysis for Planning (IMPLAN) system. IMPLAN is a computerized data base and modeling system that provides a regional input-output analysis of economic activity in terms of 10 industrial groups, involving as many as 528 sectors (Alward et al. 1985, MIG, Inc. 2000). IMPLAN is designed to estimate job and income impacts from changes in final demand, including the volume of export trade generated by individual sectors in a single county or multi county region. Revisions were made to the IMPLAN model to depict the specific character of the wood industry and other related sectors within the 14-county region. These revisions reflect the survey work completed under Objective 1 and a review of the current regional economy as defined by Harris InfoSource (2004).

Objective 3

The sectors within the wood industry (Objective 2) were counter compared to the other lead components in the region to determine the relative strength and contributions of the wood industry to the economy. This was pursued through a value added ranking of all lead sectors within the region and allied evaluation of the wood product sectors (Strauss et al. 2000).

Objective 4

The U.S. Forest Service was in the first round of updating their inventory of Pennsylvania's forest resources. This involved a five-year cycle of sample plots designed to provide a comprehensive analysis of the Commonwealth's forest resources at the county level. State-wide tables have been published for the first three years (McWilliams et al. 2003). County level tables have not been published at this time because the abbreviated sample does not allow for accurate estimates at that level. However, the first four years of data collection have been completed and were available on the Forest Service's FIA web page (USDA Forest Service 2004). The four-year set of data allowed for reasonably accurate estimates for larger areas, such as the 14-county AHUG region (correspondence with W. McWilliams 2003). This resource base permitted a comparison of timber inventories to the annual harvest rates depicted in 2002 for each of the ownership groups in the region. Estimates were made of the projected strength of the timber inventory to sustain the annual consumption level of this industry.

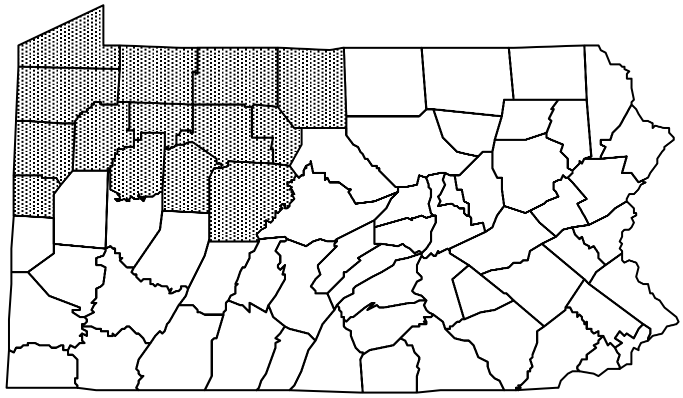
Results

Regional wood processing industries were inventoried and interviewed between December 2003 and October 2004. The initial inventory of sites was developed from the Harris InfoSource (Harris 2004). A total of 311 companies were identified as linked to the region's hardwood resource. From this inventory, 105 interviews were conducted during the sample period, meeting the needs of the sample frame and representing over one-third of the wood product industries in the region.

AHUG Region

The Allegheny Hardwood Utilization Group is a collection of wood processing industries from a 14-county region of northwestern Pennsylvania (Figure 9). Two-thirds of this region's 7.3 million acres is forested (USDA Forest Service 2004). Almost 4.7 million acres is timberland, capable of producing at least 20 cubic feet of industrial wood products per year and not withdrawn from harvesting. The majority of this timberland is in private ownership (67%), with the remainder managed by federal (10%), state (21%), and local government (2%). The federal ownership comes from the Allegheny National Forest, constituting 35% of the timberland in the four counties in which it lies (Elk, Forest, McKean, and Warren). The region is renowned for its hardwood resources, including red maple (*Acer rubrum* L.), black cherry (*Prunus serotina* Ehrh.), northern red oak (*Quercus rubra* L.), and sugar maple (*Acer saccharum* L.) (FIA 2004). These resources have sustained a timber industry in the region for over 100 years.

Figure 9. The 14-county AHUG study region.



Consistent with an area that is two-thirds forested, the 14-county AHUG region includes several of Pennsylvania's more rural counties. The overall population was 969 thousand residents in 2000 and averaged 92 people per square mile (US Census Bureau 2003).[1] The counties ranged in population from Forest with less than 5 thousand residents (12 people / sq. mi.) to Erie with 281 thousand residents (350 people / sq. mi.).

Overall, the region's economic groups produced $50 billion of output, generating over 500 thousand jobs in support of this activity. Manufacturing leads the economy with $21 billion of output. The wood industry contributes over $2.0 billion in annual sales and provides $675 million of added value to the region (Table 5). In addition to wood product manufacturing, Petroleum Refining provided 13% of manufacturing output, Railroad Equipment – 9% , Miscellaneous Plastics Production - 7%, and Fabricated Metal Products – 5%.

In terms of jobs, the region's industries employed 513 thousand people (Table 5).[2] The service industry leads with 143 thousand jobs. Wholesale and retail trade employed 110 thousand people. Manufacturing employed 100 thousand people. Wood manufacturers employed 8.0 thousand people and constituted 8% of manufacturing employment.

Table 5. The economic structure of the 14-county region.

Industry		Industry Output*	Total Value Added*	Employ.	Employee Comp.*
Agriculture		$762	$448	14,385	$85
	Timber	$202	$180		
	Consulting	$5	$3	70	$2
	Other Agriculture	$556	$265	14,315	$82
Mining		$1,020	$418	4,166	$88
Construction		$3,277	$1,238	31,499	$773
Manufacturing		$21,091	$6,547	100,023	$4,206

[1] Pennsylvania's overall average population density was 274 people pre square mile in 2000.
[2] For the purposes of this study, jobs are on a annual equivalent basis of full and part time positions. Some sectors, such as retail trade and eating and drinking places typically utilize a significant proportion of part time workers and if converted to a full time equivalent basis, would have lower employment numbers.

Logging	$124	$48	960	$22
Sawmills	$661	$155	2,369	$89
Paper, Board, and Fiber	$485	$115	636	$17.
Secondary Fiber	$54	$14	311	$11
Secondary Wood	$472	$159	3,624	$100
Other Manufacturing	$19,294	$6,056	92,123	$3,967
Transportation, Communication and Public Utilities	$4,174	$2,011	23,742	$790
Trade	$4,916	$3,518	109,609	$1,938
Finance, Insurance and Real Estate	$5,186	$3,598	24,993	$647
Services	$7,108	$4,260	142,641	$3,138
Government	$2,651	$2,366	56,827	$2,160
Other	-$2	-$2	2,870	$24
Regional Total	$50,182	$24,403	510,755	$13,849
Hardwood Total	$2,003	$675	7,970	$241

*Monetary figures are recorded in millions of dollars.
Source: Minnesota IMPLAN Group. 2001

Sector descriptions

Secondary manufacturers have been aggregated into Secondary Wood, Paper, Board and Fiber, and Secondary Fiber. In part, these aggregations have been made to avoid disclosure of confidential data specific to individual companies. This purpose was of key value in the Paper, Board, and Fiber category. The Secondary Wood Product provides an aggregation of dimension, pallet, furniture, and other solid wood product manufacturers. The remaining secondary group, Secondary Fiber Manufacturers, largely represents paper and paperboard manufacturers located in urban centers. Typically, these companies import their base material from out-of-state sources and, as such, are not dependent upon regional timber. Nonetheless, these are wood-based manufacturers.

Timber production

These businesses are primarily involved in the production of timber. In addition o private production, timber is also supplied by government land management agencies, and on sawmill-owned lands. Additional timber was also imported to the region from nearby states and counties. Black cherry and red oak accounted for half of the timber utilized by regional industries (31 and 21% respectively). Hard maple made up 8% of the input, with the remaining 40% coming from the broad variety of species that fill out the region's forests.

Timber processing companies were asked to indicate the volume, value, and source of this resource. Regional industries processed 372 million board feet of timber in 2003, valued at $284 million, placing an average value of nearly $763/mbf. The largest source of timber was from non industrial private forests (NIPF), which supplied 234 million board feet to regional industries (63%). Relatively little timber was obtained from the Allegheny National Forest (6.3 mmbf; <2%) and from state agencies (15.7 mmbf; 4.2%), even though these entities manage 33% of the region's timberland. Imports accounted for 11% of the timber utilized by the region's forest products industries (41.4 mmbf).

Consulting

These companies work with private and public forest owners/managers in the management of the forest resource. One additional company in this sector provides fencing and herbicide spraying services to timber growers. The majority of input-output profiles for consulting companies were based upon a previous study (Strauss et. al. 2000), the Harris InfoSource (2004), and professional contacts with this sector.

The inventory of consultants identified 30 enterprises operating in the AHUG region. Along with the fencing and herbicide operation, they were estimated to have sales of over $5 million annually, employing over 70 people, and providing wages and salaries of $2.4 million.

Logging

Loggers are responsible for the harvest and transport of timber. The input-output profile for logging operations were organized from 23 surveys conducted in the 5-county study and 3 surveys of company-managed crews in this study.

Due to increasing liability issues, none of the mills producing over 5 mmbf annually maintained company-managed logging crews. However, it was estimated that half of the smaller mills utilized at least in part company fellers. Within this study, the estimated volume of logs supplied by company-managed crews was not credited to the (private) logging sector. The private logging sector was consisted of 30 businesses, employing 960 people and supporting a payroll of $22 million and output of $124 million.

Sawmills

Sawmills are a key focal point for the wood industry. The inventory of sawmills within the region consisted of 98 enterprises engaged in the production of rough and planed lumber, chips, kiln dried lumber, sawdust, and other timber products. The nine largest of these had annual capacities of over 10 million board feet (mmbf). Another eleven were in the five to ten million board foot range. There were 55 operations with fewer than five million board feet of capacity. Also included in the group were four businesses whose primary product was chips, two kiln drying centers, and nine lumber concentration yards with kilns. Interviews were conducted with 34 industries in the sector. This included eight mills in the largest category, six in the medium category, eleven in the smaller category, one kiln drying center, one chipping operation, and six concentration yards.

Sawmills were estimated to employ 2,369 people and have a payroll of $89 million. The sawmill industry produced $661 million of output and 477 million board feet of lumber in 2003. Forty percent of this volume (187 mmbf) was produced by the 9 largest mills, with 93 mmbf produced by 11 mills in the second category. The 55 mills with under 5 mmbf of annual capacity produced 197 mmbf. The sawmill sector also sold 71 mmbf of logs.

In terms of the financial value of products, 64% of the sawmill industry's output was in the form of kiln dried lumber. Green lumber accounted for only 11% of revenues. Another 20% of revenues came from the sale of logs without further value added processing. The remaining revenues came from the sale of dimension lumber (3%), chips (2%), and other products (1%).

Concentration yards bought and sold 129 mmbf of lumber during 2003. A certain portion of their output originated as lumber from regional mills, with the remainder purchased from outside the region.

Paper, Board, and Fiber

This is an aggregation of two sectors: Paper Mills, Except Building Paper and Reconstituted Wood Products. Four enterprises were found in these two sectors. All four of them were surveyed for this study. Their information has been combined to protect the confidentiality of proprietary data gained in the surveys. Together the four produced $485 million of output in 2003. They employed almost 636 people and paid over $17 million in wages and salaries.

Secondary Fiber

The region had nine companies involved in the manufacture of Paperboard Containers and Boxes. While not dependent upon regional wood sources, they are a component of the wood processing industry and are typically positioned as a secondary manufacturer of packaging products in the more urban economies. One of the major secondary fiber companies was interviewed for this survey. Totals were then based on the employment level for the entire sector as reported by Harris InfoSource (2004). The combined output for this sector was estimated at over $54 million. These businesses paid $11 million in wages and salaries in support of 311 employees.

Secondary Wood

This represents a group of companies utilizing the output of the sawmill sector, both regional and elsewhere. Their contribution to the region's economy is the value added to sawmill output as they serve individual niches of the wood products market. Interviews were conducted with 13 of the larger producers in this assembly of 142 enterprises. The enterprises in this group had $472 million in sales in 2003. Over 3,600 people were employed in manufacturing secondary wood products, earning $100 million in wages and salaries. Key sectors within this group were Dimension with $113 million in output and 755 employed, Wood Products Not Elsewhere Classified with $80 million in output and 553 employed, and Prefabricated Wood Buildings with $57 million in output and 474 employed.

Economic impacts

Total sales impacts generated by the region's wood products industry were $2.7 billion representing $1.5 billion of direct impacts and $1.2 billion in secondary impacts. Almost 17 thousand people were employed as a result of this total activity involving $0.43 billion in wages and salaries. Key areas of the economy benefiting from timber processing include Agriculture ($231 million revenues), Services ($159 million), Transportation, Communications and Public Utilities ($147 million), Trade ($144 million), and Finance, Insurance, and Real Estate ($111 million) (Table 6).

The top 15 individual industries in terms of value added impacts are identified in Table 7. The largest value added impacts after the wood products and timber sectors were the Wholesale Trade sector ($48 million), Motor Freight Transport and Warehousing ($31 million). For the most part, these were indirect impacts supporting the wood products sectors. Owner-occupied Dwellings were the next largest source of impacts ($25 million). This sector represents the accumulation of equity by home owners employed in impacted industries. This is one of the key sources of induced impacts accruing to the people of the AHUG region as a result of the area's timber resources. Doctors and Dentists ($16 million), Hospitals ($14 million), Eating and Drinking ($11 million), Miscellaneous Retail ($9.7 million), Automotive Dealers and Service Stations ($9.6 million), and Food Stores ($8.9 million) were further examples of the induced impacts from regional employees. Maintenance and Repair Other Facilities ($15 million) was principally based upon indirect impacts. The impact from banking ($21 million) was largely split between indirect and induced. Other sectors that were split between indirect and induced impacts include Real Estate ($16 million) and Electric Services ($16 million).

Table 6. Secondary sales impacts, value added and employment gains from wood product manufacturing.

Sector	*Direct Sales*	*Total Sales*	*Value Added*	*Employee Income*	*Employment (Jobs)*
Agriculture	$0.0	$230.9	$194.7	$4.3	510
Mining	$0.0	$11.7	$4.5	$0.8	49
Construction	$0.0	$24.6	$16.1	$10.2	407
Manufacturing	$0.0	$98.9	$26.2	$14.2	356
Wood	$1,476.0	$1,715.3	$469.2	$228.2	7,544
Transportation, Communications, and Public Utilities	$0.0	$147.4	$70.1	$31.0	976
Trade	$0.0	$143.9	$100.3	$56.0	2,788
Finance, Insurance, and Real Estate	$0.0	$110.5	$75.3	$16.0	618
Services	$0.0	$158.8	$94.5	$65.1	3,101
Government	$0.0	$15.0	$6.0	$5.2	114
Other	$0.0	$0.6	$0.6	$0.6	66
Total	$1,476.0	$2,657.6	$1,057.4	$431.6	16,529

Timber supply

The US Forest Service's ongoing forest inventory of Pennsylvania shows the 14-county AHUG region to have 4.6 million acres of timberland with 31.8 billion board feet of sawtimber.[3] Principal species include red maple (7.7 billion board feet), black cherry (6.3 billion board feet), northern red oak (3.3 billion board feet), and sugar maple (3.1 billion board feet) (Appendix C).

Table 7. Secondary sales impacts, value added and employment gains from wood product manufacturing registered in key sectors within AHUG, 2003..

Sector	*Direct Sales*	*Total Sales*	*Value Added*	*Employee Income*	*Employment (Jobs)*
Wood	$1,476.0	$1,715.3	$469.2	$228,158,528	7,544
Forestry Products	$0.0	$201.5	$180.5	0	0
Wholesale Trade	$0.0	$69.9	$48.0	$27,045,190	783
Motor Freight Transport and Warehousing	$0.0	$71.5	$31.0	$16,930,722	654
Owner-occupied Dwellings	$0.0	$32.9	$24.9	$0	0
Banking	$0.0	$31.2	$20.7	$5,821,792	175
Doctors and Dentists	$0.0	$24.1	$16.0	$12.4	264
Real Estate	$0.0	$22.3	$15.9	$0.9	133
Electric Services	$0.0	$18.7	$15.8	$3.1	45
Maintenance and Repair Other Facilities	$0.0	$22.4	$15.3	$9.8	387
Hospitals	$0.0	$22.7	$13.8	$11.5	358
Eating & Drinking	$0.0	$22.5	$11.0	$7.0	712
Miscellaneous Retail	$0.0	$12.5	$9.7	$4.7	361
Automotive Dealers & Service Stations	$0.0	$12.8	$9.6	$5.2	214
Food Stores	$0.0	$9.8	$8.9	$5.1	310
Sum 15-Sector	$1,476.0	$2,290.0	$890.3	$337.9	11,940
Total	$1,476.0	$2,657.6	$1,057.4	$431.6	16,529

Over half of this sawtimber was located on private lands, 29% on state lands, 15% on federal property, and 2% on local government timberland.[4]

The Forest Service's Forest Vegetation Simulator (FVS) estimated total sawtimber volumes to be growing at an annual rate of 158 board feet per acre (Table 8).[5] However, average growth rates did vary with ownership. ANF timber was estimated to be growing at an annual rate of 237 board feet per acre. In contrast, state and local government managed timber had an annual growth of 183 board feet per acre and annual timber growth on private lands was 137 board feet per acre. Total growth was estimated at 725 million board feet per year; more than enough to supply the 372 million board feet that

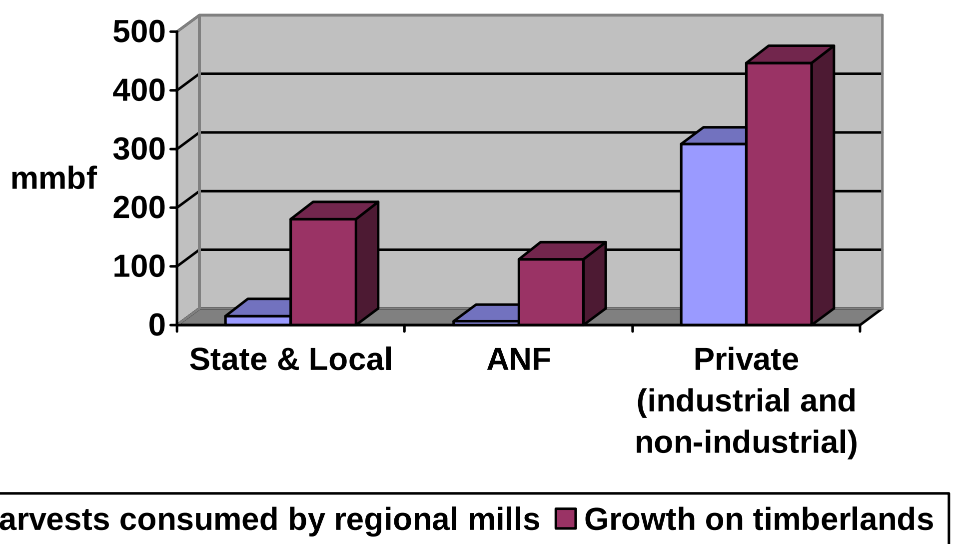
[3] Based upon first four of five inventory cycles (2000 – 2003).
[4] Due to privacy issues, the Forest Service is no longer able to provide detailed ownership of the private acreage. Previous inventories had identified company owned timber as well as farm woodlots and other forms of privately owned timber.
[5] The Forest Vegetation Simulator is a growth and yield model that can be used to project forest inventories for a variety of species, forest types, and stand conditions (Dixon 2003). Variants are available for 21 regions of the United States, including the northeast.

the industry processed in 2003. However, an examination of the breakdown by ownership showed an increased harvest pressure on privately owned timber in the region. The 309 million board feet harvested from private lands by regional mills was 72% of the growth on these properties.[6] Meanwhile only 9% of the growth on state land was being harvested by local mills. On the Allegheny National Forest, harvests by regional mills represented 6% of growth. If this level of harvest is to be sustained, then the share of timber harvested from private and public forests needs to be allocated in a more equitable fashion.

Table 8. Comparison for current timber volumes and growth with harvests.

Ownership	*Current harvests (mmbf)*	*Current Volume (mmbf)*	*Annual Growth (bdft/ac)*	*Acres*	*Total Growth (mmbf)*
State&Local	16	9,979	183	988,792	181
ANF	6	4,783	237	475,000	113
Private (industrial and non-industrial)	309	17,070	137	3,147,850	431
Import	41				
Total	372	31,831	158	4,611,642	725

Figure 10. Timber growth and harvests by public ownerships, 2003.



References

Alerich, C.L. 1993. Forest Statistics for Pennsylvania – 1978 and 1989. USDA Forest Service Resource Bulletin NE-126. 242p.

[6] These figures do no include harvests by non regional mills. Owing to the high quality of sawtimber available from the region, timber exports may very well exceed the 41.4 mmbf currently being imported into the region.

Alward, G.S., H.C. Davis, K.A. Depotakis, and E.M. Lofting. 1985. Regional non-survey input-output analysis with IMPLAN. Paper presented at the Southern Regional Science Association Conference. Washington, DC. May 9-10, 1985. 12p.

Dixon, G.E. comp. 2003. Essential FVS: A user's guide to the Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Forest Management Service Center. 193p.

Harris InfoSource. 2004. Business Information Products. http://www.harrisinfo.com. Accessed October 2004

Lord, B.E. and C.H. Strauss. 1993. A review and validation of the IMPLAN model for Pennsylvania's solid hardwood product industries. IN: Proceedings of the 9th Central Hardwood Forest Conference. Northeastern Forest Experiment Station Gen. Tech Rpt. pp78-81.

McWilliams, W.H., C.H. Alerich, D.A. Devlin, A.J. Lister, T.W. Lister, S.L. Sterner, and J.A. Westfall. 2003. Annual Inventory Report for Pennsylvania's forests: Results from the First Three Years. USDA Forest Service Resource Bulletin NE-159. 95 p.

Minnesota IMPLAN Group. 2001. IMPLAN System (data and software). 1725 Tower Drive West, Suite 140, Stillwater, MN 55082 www.implan.com

Office of Management and Budget. 1987. Standard Industrial Classification Manual. Executive Office of the President, Office of Management and Budget, Washington, DC. 705 p.

Powell, D.S. and T.J. Considine. 1982. An analysis of Pennsylvania's forest resources. USDA Forest Service Resource Bulletin NE-69. 97p.

Steer, H.B. 1948. Lumber Production in the United States 1799-1946. USDA Misc. Pub No. 669. Wash. D.C. 233 p.

Strauss, C.H. and W.H. McWilliams. 1987. Potential sawtimber availability in northcentral Pennsylvania: The next three decades. Northern Journal of Applied Forestry. Vol. 4, No. 3, 119-123.

Strauss, C.H. and R.G. Lord. 1989. Timber availability in northcentral Pennsylvania: The next hundred years. Northern Journal of Applied Forestry. Vol. 6, No. 3, 133-137.

Strauss, C.H. 1990. Economic potential of increased timber availability in northcentral Pennsylvania. In: Proceedings of Seventh Central Hardwood Forest Conference USDA Forest Service and Southern Illinois University. pp 203-214.

Strauss, C.H., B.E. Lord, A.Z. Rose, T.J. Considine, and P.C. Li. 1991. Market Analysis of the Solid Hardwood Products Industry in Pennsylvania. Final Report to Governor's

Response Team, Pennsylvania Department of Commerce. Penn State School of Forest Resources and Department of Mineral Economics, University Park, PA. 126 p.

Strauss, C.H., M. Shields, T.W. Kelsey, B.E. Lord, and M.J. Powell, 2000. Economic Impact of Pennsylvania's Hardwood Industry: Current Status and Proposed Growth. Project report to Pennsylvania Hardwood Development Council. PSU School of Forest Resources. University Park, PA. 66 p.

USDA Forest Service. 2004. Forest inventory mapmaker web-application 1.7. St. Paul, MN. U.S. Department of Agriculture, Forest Service, North Central Research Station. Webpage: www.ncrs2.fs.us/4801/fiadb/index.htm. Accessed 11/16/2004.

Westman, E.D., C.H. Strauss and R.S. Bond. 1985. A description of the forest product industries in the Allegheny Region of Pennsylvania. Research Paper No. 47, July 1985. School of Forest Resources. The Pennsylvania State University. University Park, PA. 39p.

Evaluating the Change in Regional Economic Contributions

of Forest-Based Industries in the South[1]

Bart K. Tilley[2] and Ian A. Munn[3]

[1]This manuscript is publication # FO310 of the Forest and Wildlife Research Center, Mississippi State University.
[2]Graduate Research Assistant, Department of Forestry, Mississippi State University, Box 9681, Mississippi State, MS 39762. bkt2@msstate.edu (662) 325-8358 (v); (662) 325-8726 (fax).
[3]Professor, Department of Forestry, Mississippi State University, Box 9681, Mississippi State, MS 39762. imunn@cfr.msstate.edu (662) 325-4546 (v); (662) 325-8726 (fax).

Abstract
Forestry is the dominant land-use in the South and forest-based industries have a major impact on the region's economy. This impact, however, has been changing over time both in terms of relative magnitude and location within the region. These changes have policy implications for the industry and its constituents. The economic impact of the forest-based industry was assessed for the region and individually for the 13 states comprising the region. This impact was modeled using the computer software Impact Analysis for Planning (IMPLAN) and data for 2001. Results were compared to a similar assessment from the early 1990's by Aruna et al. (1997) to determine changes in the relative importance of the industry to the region's economy over time. The number of individuals employed in forest-based industries over this time period increased by 84,800 full- or part-time jobs to 718,000, but as a percentage of total employment in the South, decreased from 1.5% to 1.3%. The forest-based industries value of shipments increased by \$54 billion to \$124 billion and increased as a percentage of the total manufacturing value of shipments from 7.8% to 9.6%. Manufacturing value-added also increased by \$24 billion to \$56 billion and the percentage of total manufacturing value-added increased from 8.0% to 9.1%. This indicated that, while the industry expanded in both absolute terms and as a percentage of the regional economy, it became relatively less labor intensive.

Introduction

Forest-based industries in the South provide a major contribution to the state economies (Leatherman and Marcouiller 1999). The forest-based industry in the southeastern U.S. has become a leading supplier of the country's forest products, supplying 60 % of the Nation's forest products (Prestemon and Abt 2002). As demand from forest-based industries increases, their contribution to the economy will also become more prominent. The predominant land cover type of most southern states is timber land (Wear 2002). This resource base allows forest-based industries to obtain their raw materials almost exclusively from local supplier inputs, thereby increasing their economic contribution. A resource base of over 199 million acres of timber land in the South provides an opportunity for increased importance of the southern forest-based industry (Abt et al. 2002). Most southern states are generally rural areas in which forest-based industries are a major employer. Without the operation of these industries many states would lose an important component of their economic activity (Munday and Roberts 2001).

Aruna et al. (1997) performed a study using Impact Analysis for Planning (IMPLAN) to determine the economic contributions of each southern state's forest-based industry. Their study, based on the 1992 IMPLAN database, provided employment and multipliers for output, value added, income, and employment resulting from forest-based industries. Southern forest-based earnings were obtained from the American Forest and Paper Association's Facts and Figures report for 1990. The U.S. Department of Commerce 1991 Annual Survey of Manufacturers report was used for value of shipments, manufacturing value-added, and Gross State Product (GSP). The forest-based industry's economic contribution of each state was compared with that of the other states to determine its relative importance to the economy. The purpose of this project is to evaluate the change in the economic contributions of forest-based industries in the South since 1992. By evaluating changes in the forest-based industries' contribution to the southern economy, important trends in the industry can be identified (e.g. relative and absolute importance and geographic changes within the region.)

Objectives

1. Determine the economic contribution of forest-based industries for each of 13 southern states and the region by calculating employment, earnings, value of shipments, and value-added using comparable data.
2. Determine the relative importance of forest-based industries to the state economies.
3. Compare and contrast our results to those found by Aruna et al. (1997) and discuss similarities/differences and changes over time.

Methods

Data comparable to that used by Aruna et al. (1997) was used to evaluate changes since 1992 and the current state of the forest-based industries in the South. The 2001 IMPLAN database used in our study reflected the reconfiguration in the sector classification used by IMPLAN from 528 sectors to 509 sectors. The Minnesota IMPLAN Group (MIG, Inc.) provided information on how the new sectors related to the old. This was used to aggregate the 2001 data comparable so it was to the 1992 data Aruna et al. (1997) used.

The 2001 IMPLAN sectors were aggregated into three sectors, lumber and wood products, paper and allied products, and wood furniture which follow. The lumber and wood products sector consisted of logging; sawmills; wood preservation; reconstituted wood product manufacturing; veneer and plywood manufacturing; engineered wood member and truss manufacturing; cut stock, resawn lumber, and planning; other millwork, including flooring; wood container and pallet manufacturing; prefabricated wood building manufacturing; and miscellaneous wood product manufacturing sectors. The paper and allied products sector contained pulp mills; paper and paperboard mills; paperboard container manufacturing; surface-coated paperboard manufacturing; coated and laminated paper and packaging materials; coated and uncoated paper bag manufacturing; die-cut paper office supply manufacturing; envelope manufacturing; sanitary paper product manufacturing; and all other converted paper product manufacturing sectors. The wood furniture sector consisted of wood windows and door manufacturing; wood kitchen cabinet and countertop manufacturing; upholstered household furniture manufacturing; nonupholstered wood household furniture manufacturing; institutional furniture manufacturing; other household and institutional furniture; wood office furniture manufacturing; custom architectural woodwork and millwork; and showcases, partitions, shelving, and lockers sectors. These aggregated sectors were used to obtain forest-based employment data and economic multipliers for employment, total and personal income, total output, and value-added.

Forest-based earnings were obtained from the American Forest and Paper Association's Forest Facts and Figures 2001 report, which reported 1998 data. Manufacturing value-added, manufacturing value of shipments, and gross state product values were obtained from the U.S. Department of Commerce, 2001 Annual Survey of Manufacturers. These data were collected for the region as a whole and each of the 13 individual states comprised Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

To determine the relative importance of the forest-based industries to each state's economy, an average ranking of employment, earnings, value of shipments, and value-added was computed for the Aruna (1997) and the current data. Individual rankings were constructed using the percentage of the economy each factor accounted for in each state. The state with the highest percentage was ranked first, the second highest percentage second, and for each state. The four ranks were summed and divided by four to determine the average state rank. This provides a rough measure of the relative importance to the forest-based industries to the state economy because it measures the importance in relation to the rest of the economy.

Results

In 2001, southern forest-based industries employed 718,176, up from 633,367 jobs in 1992 (Table 1). Although the region and each state experienced an increase in total employment over this time period, there was a resulting decrease in the relative employment from 1.5% in 1992 to 1.3% in 2001. Forest-based employment in the South decreased as a percentage of total U.S. forest-based employment from 39.9% to 39.0%. Alabama and Virginia were the only two states to have a decline in total forest-based employment over this time period, losing 2,142 and 1,580 jobs, respectively, accounting for 3.6% and 2.6% of their 1992 forest-based employment. Mississippi and Kentucky were the only two states in which forest-based industries increased in relative terms, accounting for an additional 0.6% and 0.1%, respectively, of total state employment. Employment in the lumber and wood products sector increased only in Louisiana and Oklahoma, while the South increased from 34.8% in 1992 to 41.5% in 2001 relative to the total U.S. lumber and wood products sector employment. Employment in the wood furniture sector increased in every state and the region, but decreased as a percentage of total U.S. wood furniture sector employment, from 57.2% to 39.7%. Arkansas, Kentucky, South Carolina, and Texas were the only states that had increases in paper and allied products sector employment, but employment in the South still increased from 28.1% of U.S. paper and allied products sector employment in 1992 to 35.2% in 2001.

Forest-based industries earnings increased $3.3 billion in nominal dollars for the region from 1990 to 1998, but as a percentage of total earnings in the South, decreased from 1.4% to 1.3% (Table 2). Florida, North Carolina, Tennessee, and Virginia also experienced a decrease. Earnings from each of the southern forest-based industries sectors increased as a percentage of total U.S. earnings in the paper and allied products sector from 31.5% to 34.0% and in the lumber and wood products sector from 34.8% to 39.4%. Even though southern forest-based employment decreased as a percentage of total U.S. employment, southern forest-based earnings increased as a percentage of total U.S. forest-based earnings from 33.1% in 1990 to 36.5% in 1998.

Value of shipments from southern forest-based industries increased in nominal dollars for the region and each state and accounted for 39.5% of the total U.S. forest-based value of shipments in 2001 (Table 3). Louisiana's forest-based value of shipments, as a percentage of total manufacturing value of shipments more than doubled, increasing from 3.0% to 7.3% between 1991 and 2001. Mississippi experienced the largest increase in forest-based value of shipments as a percentage of the state's total manufacturing value of shipments of 6.8%, from 15.5% to 22.3%. Value of shipments as a percentage of the state total decreased in South Carolina, Oklahoma, and Georgia, but the South overall saw an increase from 7.8% to 9.6%.

Manufacturing value-added attributed to southern forest-based industry increased as a percentage of total manufacturing value-added from 8.0% in 1991 to 9.1% in 2001 (Table 3). Arkansas, South Carolina, and Oklahoma's forest-based value-added decreased as a percentage of total manufacturing value-added, while the other states increased. Mississippi had the largest increase in percentage of total manufacturing value-added from 15.5% to 23.5%. Although Louisiana had the largest increase in manufacturing value of shipments, this increase does not appear to have been captured with a similar increase in manufacturing value-added, with only an increase of 1.5% (10.0% to 11.5%). Value-added as a percentage of Gross Domestic Product (GDP) for the South, which according to the U.S. Census Bureau measures the market value of the goods and services produced by labor and property located in the area, remained unchanged at 1.9% (Table 3). Kentucky, Mississippi, Texas, and Virginia's value-added increased as a percentage of Gross State Product (GSP), indicating that the economic contribution from the forest-based industries in these states increased more than other industries.

There have been substantial shifts within the region over this time period. The paper and allied products sector employment accounted for 33.2% of the total southern forest-based employment in 1992 compared to 27.4% in 2001. Employment in the lumber and wood products sector accounted for 46.8% in 1992, but decreased to 35.5% in 2001. Wood furniture sector employment increased from 18.5% to 36.2% over the same time period.

Mississippi ranked first in every category but forest-based earnings, and had an overall rank of 1.3 (Table 4). Arkansas and Alabama were ranked 2nd and 3rd with scores of 2.3 and 2.8 respectively, and were in the top three with Mississippi in every category except forest-based earnings where Alabama ranked 4th. The next closest ranking was Georgia with a score of 5.3, nearly twice the 3rd ranked state. In 1992, Arkansas ranked first in all four categories, with Mississippi and Alabama at 2nd and 3rd scoring 2.0 and 2.25, respectively. Georgia was ranked 4th with a score of 2.25, more than twice the 3rd place score. Overall, there was relatively little change in the rankings. North Carolina had the largest absolute change in relative score from 7.5 in 1992 to 6.0 in 2001 and went from 8th place to being tied with South Carolina for 6th place.

Conclusions

Forest-based industries in the South were less labor intensive in 2001 than in 1992 and account for a smaller percentage of total U.S. forest-based employment. However, the industry accounted for the same percentage of total southern earnings and a larger percentage of total U.S. forest-based earnings. Forest-based industries have become more important in terms of manufacturing, comprising a larger percentage of manufacturing value of shipments and manufacturing value-added than in 1992. Despite this increase, forest-based industry manufacturing value-added accounted for the same percentage of the South's GDP, indicating that other, non-manufacturing sectors have increased in importance in the economy to offset the increase in terms of manufacturing. In relative terms, forest-based industries are more important in Mississippi, Arkansas, and Alabama than in other states because they were the top three states in forest-based earnings, value of shipments, and value-added in terms of state total and in the top four in employment, thus decreases in forest-based industries would have a larger impact.

Literature Cited

Abt, K.L., S.A. Winter, and R.J. Huggett, Jr. 2002. Local Economic Impacts of Forests. P. 239-268 *In* Southern Forest Resource Assessment. USDA Forest Serv., Southern Research Station, Asheville, NC..

American Forest & Paper Association. 2001. U.S. Forest Facts and Figures Report. AF&PA. Washington, DC.

Aruna, P.B., F.W. Cubbage, K.J. Lee, and C. Redmond. 1997 Regional economic contribution of the forest-based industries in the South. Forest Prod. J. 47(7/8):35-45.

Leatherman, J.C., and D.W. Marcouiller. 1999. Study area specification in forestry economic impact analysis: Modifying county-level secondary data. North. J. Appl. For. 16(3):129-136.

Minnesota IMPLAN Group (MIG). 1997. IMPLAN Professional™: User's Guide, Analysis Guide, Data Guide. Minnesota IMPLAN Group, Inc. Stillwater, Minnesota.

Munday, M., and A. Roberts. 2001. The role of the forest industry transactions in the rural economy. J. Rural. Stud. 17(3):333-346.

Prestemon, J.P., and R.C. Abt. 2002. Timber Products Supply and Demand. P. 299-326 *In* Southern Forest Resource Assessment. Southern Research Station, Asheville, NC.

Wear, D.N. 2002. Land Use. P. 153-174 *In* Southern Forest Resource Assessment. Southern Research Station, Asheville, NC.

U.S. Department of Commerce. 2001. Annual Survey of Manufacturers.

Geographic Area Statistics. Economics and Statistics Administration, Bureau of the Census, Washington, DC.

Table 1a. 1992 Southern forest-based employment from 1992 IMPLAN database (Aruna et al. 1997).

State	Total State Employment	Forestry	Paper and Allied Products	Wood Furniture	Lumber and Wood Products	Total Forest-Based	Total Forest-Based as % of Total State
	number of employees						%
Alabama	2,129,834	849	21,148	5,867	30,969	58,833	2.8
Arkansas	1,274,478	316	14,172	5,370	22,509	42,367	3.3
Florida	7,111,231	1,570	13,464	5,667	19,210	39,911	0.6
Georgia	3,768,056	1,405	31,228	4,714	28,960	66,307	1.8
Kentucky	2,016,886	245	8,904	2,404	16,454	28,007	1.4
Louisiana	2,060,312	402	12,214	455	13,039	26,110	1.3
Mississippi	1,249,574	305	8,970	4,154	28,101	41,530	3.3
North Carolina	4,055,213	591	22,714	46,023	38,893	108,221	2.7
Oklahoma	1,696,144	122	3,911	1,271	3,699	9,003	0.5
South Carolina	1,953,687	992	11,848	3,375	15,296	31,511	1.6
Tennessee	2,873,863	423	21,247	11,762	21,438	54,870	1.9
Texas	9,354,518	974	23,638	7,795	32,558	64,965	0.7
Virginia	3,776,416	1,310	16,647	18,598	25,177	61,732	1.6
South Total	43,320,212	9,504	210,105	117,455	296,303	633,367	1.5
U.S. Total	139,676,090	33,764	701,800	205,190	852,200	1,587,764	1.1
South % of U.S.	31.0	28.1	29.9	57.2	34.8	39.9	

Table 1b. 2001 Southern forest-based employment from 2001 IMPLAN database.

State	Total State Employment	Forestry	Paper and Allied Products	Wood Furniture	Lumber and Wood Products	Total Forest-Based	Total Forest-Based as % of Total State
	number of employees						%
Alabama	2,421,223	338	16,356	14,530	25,467	56,691	2.3
Arkansas	1,517,570	546	13,479	9,926	20,362	44,313	2.9
Florida	9,172,732	838	11,614	19,008	17,077	48,537	0.5
Georgia	4,964,658	1,018	27,910	16,144	26,761	71,833	1.4
Kentucky	2,327,652	57	10,616	8,415	16,047	35,135	1.5
Louisiana	2,502,534	548	10,542	1,732	13,544	26,366	1.1
Mississippi	1,481,891	459	7,762	27,121	21,748	57,090	3.9
North Carolina	4,924,710	517	21,148	71,997	29,921	123,583	2.5
Oklahoma	2,064,469	113	2,930	3,753	4,265	11,061	0.5
South Carolina	2,280,026	381	14,736	6,129	13,121	34,367	1.5
Tennessee	3,472,042	209	20,573	23,762	17,172	61,716	1.8
Texas	12,638,113	835	26,004	32,058	28,435	87,332	0.7
Virginia	4,523,325	175	13,367	25,914	20,696	60,152	1.3
South Total	54,290,945	6,034	197,037	260,489	254,616	718,176	1.3
U.S. Total	168,743,115	11,875	559,692	655,420	613,772	1,840,759	1.1
South % of U.S.	32.2	50.8	35.2	39.7	41.5	39.0	

Table 2a. 1990 Southern forest-based earnings by state and forest-based sector (Aruna et al. 1997).

State	Total State Earnings	Forestry	Paper and Allied Products	Lumber and Wood Products	Total Forest-Based	Total Forest-Based as % of Total State
	millions $					%
Alabama	43,672	22	963	687	1,672	3.8
Arkansas	23,617	17	484	481	982	4.2
Florida	150,022	18	513	545	1,076	0.7
Georgia	85,021	32	1,245	782	2,059	2.4
Kentucky	39,235	0	309	286	595	1.5
Louisiana	43,561	9	527	308	844	1.9
Mississippi	22,622	11	331	618	960	4.2
North Carolina	82,612	8	827	883	1,718	2.1
Oklahoma	33,764	1	129	79	209	0.6
South Carolina	39,208	37	659	365	1,061	2.7
Tennessee	58,349	3	743	490	1,236	2.1
Texas	214,975	14	868	761	1,643	0.8
Virginia	86,737	2	612	646	1,260	1.5
South total	923,395	174	8,210	6,931	15,315	1.7
U.S. total	3,378,897	350	26,024	19,938	46,312	1.4
South % of U.S.	27.3	49.7	31.5	34.8	33.1	

Table 2b. 1998 Southern forest-based earnings by state and forest-based sector.

State	Total State Earnings	Forestry	Paper and Allied Products	Lumber and Wood Products	Total Forest-Based	Total Forest-Based as % of Total State
	millions $					%
Alabama	50,502	38	1,046	961	2,045	4.0
Arkansas	26,612	19	571	543	1,134	4.3
Florida	181,733	39	582	555	1,176	0.6
Georgia	110,011	56	1,464	1,211	2,731	2.5
Kentucky	45,559	0	427	297	724	1.6
Louisiana	49,382	25	543	379	946	1.9
Mississippi	26,648	31	397	682	1,110	4.2
North Carolina	103,644	26	962	1,100	2,089	2.0
Oklahoma	35,419	3	165	92	260	0.7
South Carolina	45,544	44	830	392	1,266	2.8
Tennessee	72,123	6	863	532	1,401	1.9
Texas	266,423	25	1,123	1,154	2,302	0.9
Virginia	103,582	12	798	668	1,478	1.4
South Total	1,117,181	324	9,771	8,567	18,662	1.7
U.S. Total	3,885,668	621	28,736	21,741	51,098	1.3
South % of U.S.	28.8	52.1	34.0	39.4	36.5	

Source: American Forest and Paper Association Facts and Figures 2001 Report

Table 3a. 1991 Southern forest-based industries (FBI) manufacturing sector value of shipments, value-added, and gross state product (GSP).

	Value of Shipments			Manufacturing Value Added				
	All	FBI	%	All	FBI	%	GSP	VA%of GSP
Alabama	48,448	8,051	**16.6**	21,056	3,652	**17.3**	74,347	**4.9**
Arkansas	31,084	5,172	**16.6**	12,825	2,261	**17.6**	40,748	**5.5**
Florida	59,275	4,900	**8.3**	29,054	1,928	**6.6**	255,162	**0.8**
Georgia	82,764	10,529	**12.7**	36,576	4,414	**12.1**	143,741	**3.1**
Kentucky	53,500	2,606	**4.9**	23,713	954	**4.0**	70,115	**1.4**
Louisiana	63,381	1,916	**3.0**	22,125	2,220	**10.0**	95,606	**2.3**
Mississippi	31,196	4,833	**15.5**	12,880	1,993	**15.5**	41,704	**4.8**
North Carolina	118,206	7,497	**6.3**	59,914	3,164	**5.3**	147,847	**2.1**
Oklahoma	28,418	1,631	**5.7**	11,958	761	**6.4**	57,983	**1.3**
South Carolina	47,515	5,431	**11.4**	22,490	2,597	**11.5**	66,658	**3.9**
Tennessee	69,549	4,960	**7.1**	32,499	2,219	**6.8**	101,335	**2.2**
Texas	204,001	7,345	**3.6**	77,569	3,081	**4.0**	396,327	**0.8**
Virginia	61,642	5,284	**8.6**	33,245	2,346	**7.1**	174,444	**1.3**
South Total	898,979	70,155	**7.8**	395,904	31,590	**8.0**	1,666,017	**1.9**

Source: U.S. Department of Commerce, 1991 Annual Survey of Manufacturers

Table 3b. 2001 Southern forest-based industries (FBI) manufacturing sector value of shipments, value-added, and gross state product (GSP).

	Value of Shipments			Manufacturing Value Added				
	All	FBI	%	All	FBI	%	GSP	VA%of GSP
Alabama	67,172	11,769	**17.5**	27,844	5,197	**18.7**	120,291	**4.3**
Arkansas	46,530	7,935	**17.1**	19,868	3,135	**15.8**	69,063	**4.5**
Florida	75,541	7,803	**10.3**	39,974	3,619	**9.1**	493,218	**0.7**
Georgia	127,624	16,118	**12.6**	57,578	7,545	**13.1**	296,786	**2.5**
Kentucky	84,180	6,037	**7.2**	31,722	2,683	**8.5**	117,151	**2.3**
Louisiana	85,488	6,269	**7.3**	22,545	2,593	**11.5**	132,899	**2.0**
Mississippi	38,560	8,597	**22.3**	15,573	3,657	**23.5**	66,233	**5.5**
North Carolina	167,124	17,875	**10.7**	91,184	8,126	**8.9**	284,769	**2.9**
Oklahoma	40,063	2,171	**5.4**	18,059	1,117	**6.2**	92,406	**1.2**
South Carolina	78,738	7,508	**9.5**	35,017	3,618	**10.3**	117,757	**3.1**
Tennessee	104,109	9,296	**8.9**	46,349	4,215	**9.1**	180,792	**2.3**
Texas	321,361	12,876	**4.0**	120,086	6,049	**5.0**	744,842	**0.8**
Virginia	92,874	10,179	**11.0**	53,043	4,745	**8.9**	275,725	**1.7**
South Total	1,329,364	124,432	**9.6**	578,842	56,300	**9.1**	2,991,932	**1.9**

Source: U.S. Department of Commerce, 2001 Annual Survey of Manufacturers

Table 4a. Relative rank of each state in terms of 1992 Southern forest-based employment, earnings, value of shipments, and value-added and average state rank.

State	Rank				
	Employment	Earnings	Value of Shipments	Value-Added	Average Rank
Alabama	3	3	1	2	2.3
Arkansas	1	1	1	1	1.0
Florida	12	12	7	9	10.0
Georgia	6	5	4	4	4.8
Kentucky	9	9	11	12	10.3
Louisiana	10	8	13	6	9.3
Mississippi	1	1	3	3	2.0
North Carolina	4	6	9	11	7.5
Oklahoma	13	13	10	10	11.5
South Carolina	7	4	5	5	5.3
Tennessee	5	6	8	8	6.8
Texas	11	11	12	12	11.5
Virginia	7	9	6	7	7.3

Table 4b. Relative rank of each state in terms of 2001 Southern forest-based employment, earnings, value of shipments, and value-added and average state rank.

State	Rank				
	Employment	Earnings	Value of Shipments	Value-Added	Average Rank
Alabama	4	3	2	2	2.8
Arkansas	2	1	3	3	2.3
Florida	12	13	7	7	9.8
Georgia	8	5	4	4	5.3
Kentucky	6	9	11	11	9.3
Louisiana	10	7	10	5	8.0
Mississippi	1	2	1	1	1.3
North Carolina	3	6	6	9	6.0
Oklahoma	12	12	12	12	12.0
South Carolina	6	4	8	6	6.0
Tennessee	5	7	9	7	7.0
Texas	11	11	13	13	12.0
Virginia	9	10	5	9	8.3

Concurrent Session 4A: Fire Economics I

Liability of Using Prescribed Fires on Forestlands and State Legislation Evolution

Changyou Sun[1]

Abstract

Escalating wildfires on forestlands in recent years have resulted in statutory changes in redefining the liability for landowners in using prescribed fires. This study summarized these reforms in recent years. While in some states there is still strict tort liability for damages from prescribed fires, eighteen states have reduced the liability burdens on landowners with simple negligence rules, and furthermore, four states with gross negligence rules. A multivariate ordered probit model across the fifty states was estimated to examine the factors that have influenced the retaining of certain liability rules in a state. Demand of prescribed fires from industrial and nonindustrial private forestland owners turned out to be the key driving force behind these statutory changes related to prescribed fires.

Keywords: burning law, liability, negligence, ordered probit, prescribed fires

[1]Assistant Professor, Department of Forestry, Mississippi State University, Mississippi State, MS 39762 (Email: csun@cfr.msstate.edu, phone: 662-325 7271, and fax: 662-325 8726).

1. INTRODUCTION

The long-term suppression fire policy nationwide in past decades has resulted in high fuel accumulations on forestlands (Mutch 1994). This has been reflected in the increasingly severe fire seasons in recent years with more acres burned, increased number of catastrophic fires, problematic containment and suppression, and increased financial costs (National Interagency Fire Center 2004).

There are various ways of reducing fuel accumulation in forests. Especially, fire itself in the form of prescribed fire can be useful in reducing wildfire risk. Except fuel reduction, there are also other benefits associated with prescribed fires: vegetation control, wildlife habitat, site preparation, disease control, visibility for harvesting and recreational use, air quality, and water quality (McNabb 2001). Research also revealed that compared to other forest practices, prescribed fire often may be the least expensive or more effective management tool available (Dubois et al. 2003).

Recognizing the wide benefits associated with prescribed fires, landowners and public agencies have increased their use of prescribed fires in recent years. On the National Forests, acres treated by prescribed fire increased by 76% between 1985 and 1994, and average annual treatment reached 908,000 acres (Cleaves et al. 2000). From 1995 to 2000, annual acreage treated on federal wildland has further increased to 1,440,000 acres (National Interagency Fire Center 2005). On private forestlands, prescribed fires also have been widely used, especially in the south. A survey study by Haines and Busby (2001) revealed that more than 4.1 million acres per year of pine-type forests were burned between 1985 and 1994 in the south; approximately 88% of them were on private and state lands. Fuels managers were asked to estimate the annual area that should be burned to achieve their goals based on the mix of resource management purposes. The Forest Service burned about 63% of the fuels managers' self-described optimum targets, compared to 48% on private and state lands.

The demand and use of prescribed fires on forestlands have been increasingly subject to various constraints. One of the most cited is potential liability with escaped fires (Haines and Cleaves 1999; Haines and Busby 2001; Brenner and Wade 2003). For instance, an escaped prescribed fire during the summer of 2000 from the Bandelier National Monument burned into the Los Alamos Canyon, forced 18,000 people to be evacuated, and destroyed 250 homes (Hesseln 2001). Escaped fires may damage neighboring properties and persons and smoke released from fires also may cause accidents on roads. For many private landowners, the possibility of getting sued and potential litigation costs have been their immediate concern in considering prescribed fires.

Given the demand for prescribed fires from land management community and the concern of liability, state legislators have responded by revising state liability laws in recent years. In this regard, the State of Florida has been leading these statutory reforms. In 1990, Florida passed the Prescribed Burning Act, nationally recognized as landmark legislation in protecting a landowner's right to use fire as a management tool. Under the Act, a landowner or burner is not civilly liable for damages unless simple negligence in using prescribed fire is found. Furthermore, in the wake of the disastrous 1998 fire season in Florida, the Florida legislature modified its previous law so that a landowner or burner cannot be found civilly liable unless a court demonstrates that the burner was "grossly negligent." According to many legal minds, that is a dramatic change and reduction of liability burden on landowners in using prescribed fires (Brenner and Wade 2003). Following Florida's reform, many other states have changed their laws related to prescribed burning.

This wave of statutory reforms at state legislatures about the liability in using prescribed fires has received limited coverage in the literature so far. Brenner and Wade (1992; 2003) conducted excellent reviews on these changes in Florida. Haines and Busby (2001) and Haines and Cleaves (1999) covered regulatory and voluntary programs for prescribed fire in the Southern states. Yoder et al. (2003) focused on developing a theoretical economic model of the incentive and welfare effects of prescribed burning, while the characteristics of prescribed fire liability laws were examined for some states within the context of the model. There is also a large related body of literature that examines fire risk and management (e.g., Stanton 1995; Eshee 1997; Hesseln 2000; Prestemon et al. 2002).

Given the need of a comprehensive examination of state statutory changes related to prescribed fires study in recent years, the objective of this study is two-fold. First, a complete review of legislative reforms in each state concerning with the liability of using prescribed fires will be conducted. This will cover the most recent legislation in Michigan in 2005. It also will cover some earlier reform, but largely neglected in the literature, such as the gross negligence rule in Nevada. Second, a quantitative analysis will be performed to examine why states have retained different liability rules in regulating prescribed fires. Interest group theory of government and economic theory of legislatures (Benson and Engen 1988) will be used to explain the type of burning law retained in a state. A multivariate ordered probit model will be estimated to assess the influences of various factors on the choices by state legislatures.

The rest of the paper is organized as follows. A review of state statutory regulations across states will be conducted first. The trend of these changes over time also is briefly summarized. In the third section, theoretical and empirical models will be presented in analyzing the trends. Then an ordered probit analysis of these trends will be conducted to evaluate the determinants of different negligent rules. Empirical results are presented and conclusions will follow.

2. TORT LAW AND STATE BURNING ACT

Prescribed (or controlled) burning involves the use of fire as a tool to reduce fuel accumulation, destroy competing undergrowth, prepare sites for reforestation, and enhance the perpetuation and restoration of many plant and animal communities. Nevertheless, these benefits do not come without costs. Fire is inherently dangerous and may impose risk upon others. Our society has developed regulations that prescribe standards of behavior to limit these risks, and if there is any damage from fire, these regulations may be used to assign liability (Cooter and Ulen 2000; Eshee et al. 2003).

The liability issue related to prescribe fires falls into the category of tort law. A tort is a civil wrong which is the result of some types of socially unreasonable and unacceptable behavior. In the case of prescribed fires, tort law provides the remedy to solve disputes between victims (i.e., plaintiff) and landowners (i.e., burner, injurer, or defendant). There are various tort rules and they can be divided into intentional torts, strict liability torts, and negligence torts (simple or gross). Many intentional torts such as arson are also crimes. A person who commits such an act may be sued for damages under tort law by the victim and also prosecuted under criminal law by the state. Intentional torts are so much like crimes that they are not discussed here. Instead, this review focuses on three tort rules (i.e., strict liability, simple negligence, and gross negligence), and these related burning laws currently retained in each state.

Strict liability

Strict liability or absolute liability is liability without fault. It holds a defendant liable for actions even if the defendant is entirely unintentional and nonnegligent. Under strict liability, should the activity cause any injury, the person who engaged in the activity will always be held liable regardless of precautionary measures. Three areas of strict liability have been defined by the law: ultra-hazardous activities, animals, and product liability (Eshee et al. 2003).

Forest fires have traditionally been perceived as dangerous activities. In some states, there are still heavy liability burdens on landowners or his agents who employ prescribed fires. For example, in Minnesota, a person is guilty of a misdemeanor if the person has a burning permit and fails to keep the permitted fire contained within the area described on the burning permit, or if the person fails to keep the fire restricted to the materials specifically listed on the burning permit (Minn. Stat. §88.195). In Hawaii, setting fires or causing them to be set or allowing them to escape shall be prima facie evidence of wilfulness, malice, or negligence (HRS §185-7).

Other states with similar statutory languages are Delaware, Pennsylvania, Rhode Island, and Wisconsin (Table 1). These regulations and statutes clearly express the high possibility of liability assignment on landowners if there is any damage from escaped fires. For the purpose of this study, these codes are interpreted as strict liability tort rules, or very close to strict liability rules because of the heavy liability burdens imposed on landowners.

Simple negligence

A rule of negligence requires the plaintiff to prove harm, causation, and breach of a duty (i.e., fault). Unlike a rule of strict liability, a negligence rule permits the defense that the accident occurred in spite of the fact that the defendants satisfied all the applicable standards of care. As a result, a negligence rule may allow the defendant to reduce or even avoid the liability. Negligence rules also can be further divided into simple negligence and gross negligence. Simple negligence, also referred as negligence, is carelessness or the lack of the exercise of due care toward others or their property. The standard for measuring whether or not a person is simply negligent is the reasonable prudent person.

Table 1 Summary of state prescribed burning laws

Strict liability ($Y = 0$)	Uncertain liability ($Y = 1$)	Simple negligence ($Y = 2$)	Gross negligence ($Y = 3$)
Delaware	Arizona	Alabama	Florida
Hawaii	Colorado	Alaska	Georgia
Minnesota	Connecticut	Arkansas	Michigan
Pennsylvania	Idaho	California	Nevada
Rhode Island	Illinois	Kentucky	
Wisconsin	Indiana	Louisiana	
	Iowa	Maryland	
	Kansas	Mississippi	
	Maine	New Hampshire	
	Massachusetts	New Jersey	
	Missouri	New York	
	Montana	North Carolina	
	Nebraska	Oklahoma	
	New Mexico	Oregon	
	North Dakota	South Carolina	
	Ohio	Texas	
	South Dakota	Virginia	
	Tennessee	Washington	
	Utah		
	Vermont		
	West Virginia		
	Wyoming		
N = 6	N = 22	N = 18	N = 4

Source: The online database of the Lexis-Nexis Academic Universe was searched by using the following keywords: forest and fire, controlled fire, prescribed fire, burning, liability, and negligence.

In 1990, Florida passed the Prescribed Burning Act, nationally recognized as landmark legislation in order to limit liability of trained professionals utilizing fire under appropriate circumstances. It recognizes that prescribed burning is a right of landowners and a management tool that are beneficial to public safety and the environment. The Act was designed to eliminate the presumption of fire as inherently dangerous and change the standard of liability to simple negligence and reasonable care. The Act states that no property owner or agent conducting a prescribe burning in accordance with the Act will be liable for damage caused by fire or smoke unless (simple) negligence is proven (Brenner and Wade 1992).

Following Florida's pioneer legislation in 1990, many states adopted similar prescribed burning laws and have clear tort rules of simple negligence. These states include Alabama (Ala. §9-13-270; 1995), Louisiana (La. R.S. 3:17; 1993), Mississippi (Miss. Code Ann. §49-19-301; 1992), North Carolina (N.C. Gen. Stat. §113-60.40; 1999), Oklahoma (2 Okl. St. §16-28; year not clear), South Carolina (S.C. Code Ann. §48-34-10; 1994), Texas (Tex. Nat. Res. Code §153.081; 1999), and Virginia (Va. Code Ann. §10.1-1150; 1998). There are some other states that do not have such legislation but contain similar languages and liability rules. They are also classified as states with simple negligence rules as listed in Table 1. In total, there are 18 states with simple negligence rules.

Gross negligence

Gross negligence is the lack of even slight care and the intentional failure of a defendant to carry out a duty toward others or their property in a reckless disregard of the consequences of his activity. Compared to simple negligence, gross negligence just needs a slight diligence and entails a much smaller amount of carefulness and circumspection. The standard of care for gross negligence is much lower than that for simple negligence. Thus it dramatically reduces the burden on defendant (i.e., landowner or burner in the case of prescribed fires in this study).

In 1999, Florida modified its simple negligence rule contained in the 1990 Prescribed Burning Act into a gross negligence rule (Brenner and Wade 2003). At present, in the State of Florida, a property owner or his agent is not liable for damage or injury caused by the fire or resulting smoke unless gross negligence is proven (Fla. Stat. §590.125; 1999). Similarly, Georgia adopted simple negligence rule in 1992 and gross negligence rule in 2000 (O.C.G.A. §12-6-148). Michigan adopted simple negligence rule in 1995 and gross negligence rule in 2005 (MCLS §324.51501).

Contrary to the common belief, Florida is not the first state that has gross negligence rule for prescribed fires, even though its reform may have been the most widely recognized in the literature. In 1993, Nevada actually adopted a similar gross negligence rule (NRS §527.126). According to the rule, the State of Nevada, an agency of this state or any political subdivision or local government, or any officer or employee, is not liable for any damage or injury to property or persons, including death, which is caused by a controlled fire that is authorized pursuant to the section of §527.126, unless the fire was conducted in a grossly negligent manner. Currently, Nevada has 10.2 million acres of forestlands, and 94% of them are public (Smith et al. 2004). Other state legislatures in the region with similar forestland ownership did not follow its step in giving government immunity in using prescribed fires. Thus, the differences in forestland ownership and demand of prescribed fires in the west and the south may partially explain why gross negligence tort rules have been more received in the south in recent years.

Activity levels and regulations

Different tort rules influence the behavior of parties in different ways. In the case of prescribed fire, the three tort rules examined above (i.e., strict liability, simple negligence, and gross negligence) may have different effects on the amount of activities engaged by landowners. Economic theory reveals that if bilateral precaution is possible (which is true for prescribed fires in most cases), no tort rule is efficient in achieving efficient levels of activity (Cooter and Ulen 2000). Strict liability rule assigns all liability to burner and can depress burning activities to a very low level. Simple negligence rule may result in more activities. Gross negligence rule may encourage prescribed fire activities to a level too high to society. Therefore, In order to have an efficient level of prescribed activities, an additional control variable may be needed from outside tort liability rules.

State legislators apparently recognized that and have incorporated it into the statutory reforms for prescribed burning. Along with prescribed burning acts, detailed regulations specifying precaution measures have usually been passed together. These regulations increase the cost of precautions but make the legal standard much clearer and reduce the associated liability uncertainties on landowners. For example, in 1999 Mississippi adopted the "Mississippi Prescribed Burning Act." (Miss. Code Ann. §49-19-301, et. seq.). Prescribed burning conducted under the provisions of the Act must: (a) be supervised by at least one certified prescribed burning managers; (b) be conducted pursuant to a written prescription notarized prior to the burning; (c) be permitted by the Mississippi Forestry Commission; and (d) be considered in the public interest not constituting a public or private nuisance when conducted pursuant to state air pollution statutes and rules.

In summary, across the fifty states, there exist wide differences in the liability tort rules for damages resulted from prescribed fires. There are still six states that have strict liability rules or similar and tend to hold landowners or burners liable for damages regardless of precautionary measures. Since the 1990s, statutory reforms across the states have gradually moved toward a negligence tort rule as the demand from the land management community of using prescribed fires continues to increase. At present, eighteen states have simple negligence rule and four states have gross negligence rules. Nevertheless, twenty-two states still do not have specific statutes about prescribed fires and its liability. Common laws usually are followed to assign liability. Because of the uncertainty, the liability burden for landowners in these states is usually between strict liability rule and simple negligence (Table 1). Overall, the evolution of state burning liability rules and the distribution across states present a good empirical setting to examine what factors have influenced the retaining of current state liability laws.

3. ANALYTICAL FRAMEWORK

A categorical examination was conducted on the retaining of state burning laws across the fifty states. Such an analysis was based on the notion that because legislation was not passed in a vacuum, the atmosphere within which these laws were passed should have a significant impact on their content. Based on the work of Benson and Engen (1988), interest group theory of government (demand-side) and economic theory of legislatures (supply-side) were used to explain the type of burning laws that has been retained within each state. These theories together treat the legislative process as a "market for laws."

The interest group theory of government is based upon the assumption that all legislation has the intended goal of benefiting some particular groups, and that the benefits will flow to well organized and politically powerful interest groups from relatively less powerful groups or unorganized individuals. On the supply side of the "market," a state legislature is characterized as a firm that "produces" laws. A legislature's production of laws is not costless. There are institutional constraints which limit the supply of the legislative output.

Due to the absence of data on the price of law, structural supply and demand equations are rarely estimated. Rather, as Mehmood and Zhang (2002) explained, the following general reduced form equation is estimated.

(1) $Y = f(D, S; \beta, \varepsilon)$

Y is a categorical dependant variable of burning law in a state as shown in Table 1 ($Y = 0, 1, 2, 3$). The choice of burning law in a state is hypothesized to be determined by demand side variables (D), and state legislature features (S). β is the coefficients to be estimated and ε is the error term.

Because the dependent variable in the model is categorical in nature, the use of an ordered probit model is appropriate. It assumes an underlying continuum in the categorical dependent variable but does not assume uniform increments between categories. The ordered probit model adopted here has come into fairly wide use as a framework for analyzing such categorical legislative decisions. The model can be built around a latent regression in the same manner as a binomial model (Greene 2003; Quantitative Micro Software 2005):

(2) $Y^* = X\beta + \varepsilon$.

where X is the independent variables. As usual, Y^* is unobserved and what is observed is

$$
\begin{aligned}
Y &= 0 \text{ if } Y^* \le \mu_1 \\
&= 1 \text{ if } \mu_1 \le Y^* \le \mu_2 \\
&= 2 \text{ if } \mu_2 \le Y^* \le \mu_3 \\
&= 3 \text{ if } \mu_3 \le Y^* .
\end{aligned} \tag{3}
$$

The μ's are unknown parameters to be estimated with β. A separate constant term is not separately identifiable from above limit points (μ's). The probability associated with each category can be expressed as:

$$
\begin{aligned}
&\text{Prob}(Y = 0) = \Phi(\mu_1 - X\beta) \\
&\text{Prob}(Y = 1) = \Phi(\mu_2 - X\beta) - \Phi(\mu_1 - X\beta) \\
&\text{Prob}(Y = 2) = \Phi(\mu_3 - X\beta) - \Phi(\mu_2 - X\beta) \\
&\text{Prob}(Y = 3) = 1 - \Phi(\mu_3 - X\beta).
\end{aligned} \tag{4}
$$

By definition, the sum of all probabilities is one. The log-likelihood function and its derivative can be obtained readily and optimization can be done by the usual means.

For all the probabilities, the marginal effects of changes in the regressors are:

$$
\begin{aligned}
&[\partial \text{Prob}(Y = 0)] / \partial X = -[\phi(\mu_1 - X\beta)]\beta \\
&[\partial \text{Prob}(Y = 1)] / \partial X = [\phi(\mu_1 - X\beta) - \phi(\mu_2 - X\beta)]\beta \\
&[\partial \text{Prob}(Y = 2)] / \partial X = [\phi(\mu_2 - X\beta) - \phi(\mu_3 - X\beta)]\beta \\
&[\partial \text{Prob}(Y = 3)] / \partial X = [\phi(\mu_3 - X\beta)]\beta.
\end{aligned} \tag{5}
$$

Interpreting ordered probit coefficients is not as straightforward as for ordinary least squares coefficients. In general, when X changes, only the direction of the change in the probability of falling in the endpoint rankings (i.e., $Y = 0$ or $Y = 3$ in this study) are unambiguous. Prob($Y = 0$) changes in the opposite direction of the sign of β and Prob($Y = 3$) changes in the same direction as the sign of β. The effect on the probability of falling in any of the middle rankings (i.e., $Y = 1$ or $Y = 2$) depends on the two densities and therefore it is ambiguous. The sum of marginal effects of all four categories is zero.

4. VARIABLES, HYPOTHESES AND DATA

The variables adopted, definitions, data sources, and descriptive statistics were summarized in Table 2. The design was cross-sectional, with state-level data collected primarily from the mid-1990s to current. The dependent variable (*Y*) was a categorical variable representing the variation in liability burdens of state burning laws. Y was equal to zero if a state has a statute with strict liability or similar for prescribed fires. Y was equal to one if a state has no statute or is not specific about the liability. Y was equal to two if a state has a simple negligence rule. Y was equal to three if a state has a gross negligence rule.

Along the division of interest group theory of government (demand-side) and economic theory of legislatures (supply-side), the independent variables were organized into three groups. The first group was used to represent the demand of state liability law from special interest groups. *FYNFS* was the area of the National Forests in a state. *FYIND* was the area owned by industrial forest landowners in a state. *FYNIP* was nonindustrial private forestland areas in a state. The mean of *FYNFS*, *FYIND*, and *FYNIP* was 3.0, 1.3, 7.3 million acres, respectively. In addition, *AGEN* was the number of permanent personnel in state forestry programs. Interest groups represented by these four variables are most interested in using prescribed fires and concerned with the potential liability. They definitely prefer less burdensome liability rules. State agencies also may support that because light liability rules usually come with more regulations such as obtaining permits from state forestry agencies, which in turn increases agencies' authority. Therefore, forestland acreages and the size of state forestry agencies were supposed to be positively related to the possibility of retaining state burning laws with light liability to landowners (i.e., $Y = 3$).

The second group was demographic characteristics, which was more related to general constituent interests in a state. *POPRUR* was the rural population in a state. Prescribed fires may put in danger properties of these people in the rural areas. However, many people in the rural areas may also own forestlands and demand light liability rules as landowners. So the effect of *POPRUR* was uncertain. *EDU* was the population 25 years old with advanced degrees in a state. *INC* was per capita income in a state. People with better education and higher income were perceived to be more supportive of using prescribed fires as a land management tool. So larger values of *EDU* and *INC* were expected to increase the likelihood of retaining gross negligence rule (i.e., $Y = 3$).

Table 2 Variables definitions, data sources, and descriptive statistics

Variable	Definition (source)	Mean	Mini	Maxi
Y	Categorical dependent variable (*Y* = 0, 1, 2, or 3) (a)	1.4	0.0	3.0
FYNFS	National Forests area in a state (million acres) (b)	3.0	0.0	18.5
FYIND	Industrial forestland area in a state (million acres) (b)	1.3	0.0	7.4
FYNIP	Nonindustrial private forestland area in a state (million acres) (b)	7.3	0.3	35.9
AGEN	Permanent forestry program personnel in a state (c)	312.8	23.0	3735.0
POPRUR	Rural population in a state (million) (d)	1.2	0.1	3.6
EDU	Population 25 years old with advanced degrees in a state (million) (d)	0.3	0.0	2.0
INC	Per capita income in a state ($ thousand) (d)	20.8	15.9	28.8
DAY	The maximum length of legislative sessions in calendar days in a state (e)	166.3	42.0	350.0
BIANN	A dummy variable equal to one for states with annual legislative sessions, zero with biannual (or less) (e)	0.3	0.0	1.0
SEAT	The total number of legislative seats (Senate plus House) in the legislative body in a state (e)	147.6	49.0	424.0
BICAM	The level of bicameralism in a state, defined as the size of the Senate divided by the size of the House (e)	2.9	0.0	16.7
COMIT	The total number of standing committees in a state (e)	34.6	10.0	69.0
RATIO	The total number of standing committees in a state divided by the number of legislators (e)	4.9	1.2	18.6

Data sources:
(a) Lexis-Nexis Academic Universe (see Table 1);
(b) Smith et al. (2004);
(c) The 2002 State Forestry Statistics Report by the National Association of State Foresters (http://www.stateforesters.org);
(d) 2000 Census of Population and Housing (http://factfinder.census.gov);
(e) The Council of State Governments (2004).

The third group was the characteristics of state legislatives, which represented legislative constraints discussed by Crain (1979) and Benson and Engen (1988). *DAY* was the maximum length of each state's legislative sessions in calendar days. *BIANN* was a dummy variable equal to one for states with annual legislative sessions, zero with biannual sessions or others. *SEAT* was the total number of legislative seats (Senate plus House) in each state's legislative body. As the number of decision-makers in the legislature or the length of legislative sessions increase, the transaction costs of achieving a majority rise. This constrains the legislature's ability to cater to interest groups. However, an increase in the size of the legislature or the session length increases the opportunities for potential gains from labor specialization by legislators and from lobbying by interest groups. These competing impacts result in uncertain signs for the coefficients.

BICAM was the level of bicameralism in each state, defined as the size of the Senate divided by the size of the House. Similarity between the two houses may affect production costs and the degree of meeting constituent interests (Benson and Engen 1988). *COMIT* was the total number of standing committees in each state. *RATIO* was the total number of standing committees in each state divided by the number of legislators. More standing committees and smaller groups may facilitate labor specialization and better respond to the demand from interest groups. However, as the number of committees increases, adequacy of resources may become a constraint. Overall, theories do not provide any prior expectations for these variables.

All the fifty states were included in the dataset. The status of liability rules in each state was determined by searching the online database of the Lexis-Nexis Academic Universe. Data for forestland areas by ownership were collected from Smith et al. (2004). Personnel employed by state forestry programs were from the 2002 State Forestry Statistics Report by the National Association of State Foresters (http://www.stateforesters.org). Demographic data for rural population, education, and income were from the 2000 Census of Population and Housing (http://factfinder.census.gov). The legislature characteristics were compiled from the Council of State Governments (2004).

5. EMPIRICAL FINDINGS

A multivariate ordered probit regression model was estimated to examine these factors that have affected the retaining of certain liability rules about prescribed fires in a state. Three models were estimated. Fist, considering the importance of forestland ownership and demand of prescribed fires in land management community, a regression was estimated with the three forestland variables only. Then a full model was estimated with all the explanatory variables included. Finally, a reduced model was estimated with three insignificant variables excluded using the Wald test (Quantitative Micro Software 2005). In the reduced model, two variables (*FYNFS* and *SEAT*) became significant at the 10% level or better. For all other variables, the results have been quite stable. The reduced model was selected for all of the following analyses. For these significant variables in the reduced model, marginal effects evaluated at the mean of explanatory variables were reported in Table 4.

Empirical results reported in Table 3 revealed several interesting findings. First of all, the size of forestlands by ownership in a state appeared as the key factor in determining what kind of state burning law a state would adopt. For both industrial and non-industrial private forestland acreages, the coefficients were positive and highly significant. The possibility of adopting gross negligence rule ($Y = 3$) was positively related to the size of private forestlands in a state, while that for strict negligence rule ($Y = 0$) was on the contrary. For the middle rankings, it depends on the size of forestlands in a state. At the sample mean, simple negligence rule was preferred by private landowners while uncertain liability rule was not. Furthermore, between industrial and non-industrial private forestlands, the effect of the former was at least ten times larger, as revealed by the marginal effects in Table 4. For example, the marginal effect of adopting simple negligence ($Y = 2$) was 0.149 for *FYIND* while only 0.015 for *FYNIP*. This indicated that industrial landowners might have more influences over the legislators than NIPF landowners.

Table 3 Results of the ordered probit regression

Variables	Model 1		Model 2		Model 3	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
FYNFS	0.00	-0.21	-0.04	-1.06	-0.04	-1.62*
FYIND	0.25	2.02**	0.44	3.44***	0.45	4.00***
FYNIP	0.05	2.15**	0.04	2.14**	0.05	2.28**
AGEN			0.00	0.31		
POPRUR			0.11	0.31		
EDU			1.32	1.63*	1.48	2.52***
INC			0.04	0.59	0.03	0.52
DAY			0.00	-0.84	0.00	-0.76
BIANN			-0.54	-0.78	-0.51	-0.78
SEAT			0.01	0.90	0.01	1.95**
BICAM			0.05	0.32		
COMIT			-0.07	-2.42**	-0.07	-2.67***
RATIO			-0.29	-1.95**	-0.30	-2.25**
Log likelihood (L)	-52.42		-46.19		-46.30	
Restricted L	-59.28		-59.28		-59.28	
LR statistic	13.71		26.18		25.96	
LR index (Pseudo R^2)	0.12		0.22		0.22	

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

The size of the National Forests in a state showed a negative coefficient and became significant at the 10% level in the reduced model. This is contrary to general expectation because there has been increasing use of prescribed fires on the National Forests (Cleaves et al. 2000) and reducing liability burdens on burners should be to their interests. A further examination of Table 1 revealed that currently most states that have adopted simple or gross negligence rules are in the south and east, but not in the west. Southern states have numerous private forestland owners and their demand for reducing the liability burden apparently has been much stronger and more persistent. In contrast, it turned out that large acreage of the National Forests in the west has not prompted much demand for reducing burners' liability. Nevada adopted gross negligence liability rule in 1993 but this immunity on governmental burning activities did not attract any follower in the west where public forestland ownership dominates. The negative sign and weak effect for *FYNFS* was consistent with these facts.

Among the demographic characteristics, EDU had significantly positive effect. This implied that the higher education level in a state, the larger the possibility of a state's legislature passing light liability tort rule. *POPRUR*, *INC*, and *AGEN* did not show any significant effect.

Of the six variables representing state legislatives, *SEAT*, *COMIT*, and *RATIO* were significant. The possibility for adopting light liability rules in a state was higher when there were more state legislative seats, less committees in the legislative body, and fewer committees per legislator.

Table 4 Marginal effects of standardized changes

	$Y = 0$	$Y = 1$	$Y = 2$	$Y = 3$
FYNFS	0.005	0.012	-0.014	-0.003
FYIND	-0.052	-0.126	0.149	0.029
FYNIP	-0.005	-0.013	0.015	0.003
EDU	-0.169	-0.413	0.488	0.094
SEAT	-0.001	-0.003	0.004	0.001
COMIT	0.008	0.020	-0.024	-0.005
RATIO	0.034	0.084	-0.099	-0.019

Complementary to the marginal effects at the variable means as reported in Table 4, a more comprehensive observation of the effects can be attained by showing the probability over the whole range of an explanatory variable. In Figure 1, the effect of varying the nonindustrial forestland areas in a state (i.e., *FYNIP*) on the probability of a state adopting one of the four categories of state burning laws was demonstrated, holding all other variables at their means. The graph was drawn by using the coefficients from the reduced model (i.e., Model 3 in Table 3). Each point on the graph represented the probability that a state would impose one of the four categories of state burning laws, given a specific proportion of nonindustrial private forestlands. The slope of a curve was the marginal effect of *FYNIP*.

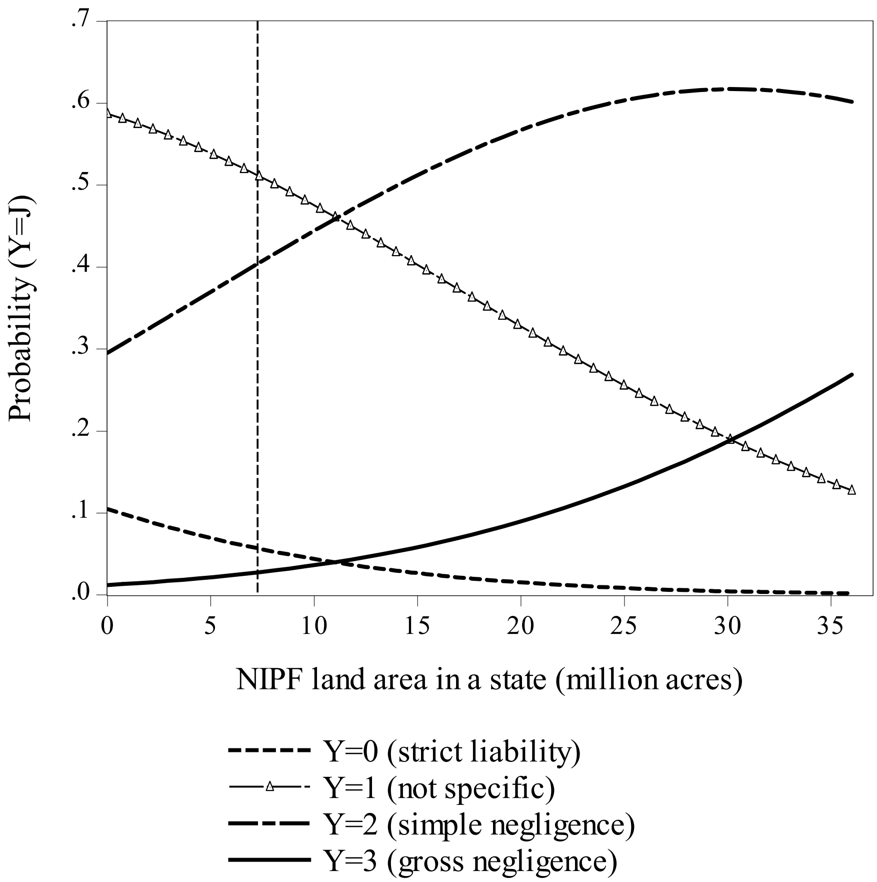
The Figure revealed several results. First, at the mean of *FYNIP* (i.e., 7.3 million acres and the dashed line in Figure 1), the slopes of the curves were these marginal effects for *FYNIP* as reported in Table 4. Second, over the most of the range of *FYNIP*, the curves for strict liability and gross negligence (i.e., $Y = 0$ and 3) were below the other two (i.e., $Y = 1$ and 2); in other words, the former had lower probabilities than the latter. This was consistent with the current status of state burning laws that most states have either simple or uncertain negligence rules. Third, the curvature revealed the signs and range of marginal effects. An upward trend of the curves indicated a positive relation (i.e., positive marginal effect) between *FYNIP* and the probability for falling in that category of *Y*, while a downward trend indicated a negative relation. For an ordered probit model, the signs of regression coefficients are consistent with these relations with the choices at end. For strict liability ($Y = 0$), the curvature was monotonically decreasing so the higher of *FYNIP* in a state, the lower the probability of strict liability tort rule in a state. For gross negligence ($Y = 3$), the relation was on the contrary. For $Y = 2$ or 3, the effects changes with the variation of *FYNIP*. This was especially apparent with simple negligence rule. Finally, when the size of nonindustrial private forestlands in a state was larger than 11 million acres, the probability of simple negligence became higher than that for uncertain tort rules, and the probability of gross negligence rule became higher than that for strict liability.

6. CONCLUSIONS

This study focused on liability burdens when landowners use prescribed fires as a management tool on forestlands. The evolution of state burning laws in recent decades has been reviewed and classified by several liability categories. A multivariate ordered probit analysis was conducted to examine the factors that might have influenced legislators' choices.

The review revealed that state statutory reforms about prescribed fires in recent years have gradually moved from heavy liability burdens on landowners toward a negligence tort rule.

Figure 1 Effects of NIPF land area on the variation of liability burdens of state burning laws



Note: The position of vertical dash line is the mean of NIPF land areas.

Currently, six states still have strict liability rules. Twenty-two states have no statutes or are not specific about liability. Eighteen states have either adopted simple negligence rules by passing Prescribed Burning Act or clearly indicate that in the regulations. Four states even passed laws to explicitly recognize gross negligence tort rule to reduce the potential liability on landowners.

These changes and evolution may reflect the demand from the land management community of using prescribed fires as a management tool. In recent several decades, wildland fires have become more severe and the demand of using prescribed fires in reducing fuel accumulations has been high. The State of Florida has been leading the changes in the south following several catastrophic fires in the state. Overall, demand of prescribed fires has driven the statutory changes in related tort laws.

The quantitative analysis through ordered probit model confirmed these impressions. Private forestlands acreages have appeared as the key factors in affecting the possibility for a state to adopt different liability rules. Larger private forestland ownership was associated with higher possibility of adopting simple and gross negligence rules. Industrial private forest landowners were even more influential, compared to nonindustrial private forestland owners. In addition, several factors charactering state legislatures also showed significant effects. States with large legislative body and few committees tended to allow light liability burdens on landowners.

Given the continued attention to forest fires, this study raised vital questions regarding the future of statutory law reforms related to prescribed fires. Future studies are needed to examine how these statutes have been interpreted in the courts. In addition, whether these statutes have encouraged the use of prescribed fires in actual forestry management and practices in recent years is a question that merits further observation and analysis.

REFERENCES

Benson, B.L. and E.M. Engen. 1988. The market for laws: an economic analysis of legislation. *Southern Economic Journal* 54(2): 732-745.

Brenner, J.D. and D. Wade. 1992. Florida's 1990 prescribed burning act. *Journal of Forestry* 90(5): 27-30.

Brenner, J.D. and D. Wade. 2003. Florida's revised prescribed fire law: protection for responsible burners. Pages 132-136 in K.E.M. Galley, R.C. Klinger, and N.G. Sugihara (eds.) Proceedings of Fire Conference 2000: The First National Congress on Fire Ecology, Prevention, and Management. Miscellaneous Publication No. 13, Tall Timbers Research Station, Tallahassee, Florida.

Cleaves, D.A., J. Martinez, and T.K. Haines. 2000. Influences on prescribed burning activity and costs in the national forest system. Gen. Tech. Rep. SRS-37. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 34 p.

Cooter, R. and T. Ulen. 2000. *Law and Economics*. 3rd ed. Addision Wesley Longman, Inc.

Crain, W.M. 1979. Cost and output in the legislative firm. *The Journal of Legal Studies* 8(4): 607-621.

Dubois, M.R., T.J. Straka, S.D. Crim, and L.J. Robinson. 2003. Costs and cost trends for forestry practices in the South. *Forest Landowner* (March/April)(2003): 3-9.

Eshee, W.D. 1997. Legal implications of using prescribed fire. Page 126-130 in D.C. Bryan (eds.), Environmental Regulation and Prescribed Fire: Legal and Social Challenges. Center for Professional Development, Florida State University.

Eshee, W.D., P. Liddell, and G. Liddell. 2003. *The Legal Environment of Business*. Rockwell Press, LLC, Starkville, MS 39759.

Greene, W.H. 2003. *Econometric Analysis*. 5th ed. New Jersey. Prentice Hall.

Haines, T.K. and R.L. Busby. 2001. Prescribed burning in the South: trends, purpose, and barriers. *Southern Journal of Applied Forestry* 25(4): 149-153.

Haines, T.K. and D.A. Cleaves. 1999. The legal environment for forestry prescribed burning in the South: Regulatory programs and voluntary guidelines. *Southern Journal of Applied Forestry* 23(3): 170-174.

Hesseln, H. 2000. The economics of prescribed burning: a research review. *Forest Science* 46(3): 322-334.

Hesseln, H. 2001. Refinancing and restructuring federal fire management. *Journal of Forestry* 99(11): 4-8.

McNabb, K.L. 2001. Prescribed burning in Alabama forests. Alabama Cooperative Extension System ANR-331. 7 p.

Mehmood, S.R. and D. Zhang. 2002. Causes for continuation of state cost-share programs for nonindustrial private forest landowners. *Forest Science* 48(3): 471-478.

Mutch, R.W. 1994. Fighting fire with prescribed fire: a return to ecosystem health. *Journal of Forestry* 92(11): 31-33.

National Interagency Fire Center. 2004. Wildland fire statistics. http://www.nifc.gov.

National Interagency Fire Center. 2005. Wildland fire statistics. http://www.nifc.gov.

Prestemon, J.P., J.M. Pye, D.T. Butry, T.P. Holmes, and D.E. Mercer. 2002. Understanding broadscale wildfire risks in a human-dominated landscape. *Forest Science* 48(4): 685-693.

Quantitative Micro Software. 2005. *EViews 5 User's Guide*. Irvine, CA 92612.

Smith, W.B., P.D. Miles, J.S. Vissage, and S.A. Pugh. 2004. Forest Resources of the United States 2002. USDA Forest Service Gen. Tech. Rep. NC-241, St. Paul, Minnesota. 137 p.

Stanton, R. 1995. Managing liability exposures associated with prescribed fires. *Natural Areas Journal* 15(4): 347-352.

The Council of State Governments. 2004. *The Book of the States 2004*. Edited by K. S. Chi. Lexington, Kentucky.

Yoder, J., M. Tilley, D. Engle, and S. Fuhlendorf. 2003. Economics and prescribed fire law in the United States. *Review of Agricultural Economics* 25(1): 218-233.

Estimating Timber Harvesting Costs For Fuel Treatment in the West: Preliminary Results

Rodrigo Arriagada and Frederick Cubbage, North Carolina State University, and Karen Lee Abt, USDA Forest Service[1]

Abstract

Preliminary of estimates of harvesting costs for forest fuel reduction treatments in the West are presented. Cost estimates were made for typical stands based on Forest Inventory and Analysis (FIA) plots that represented forest stands in 12 western states, using the ST Harvest spreadsheet system. Costs were estimated for a range of harvesting systems, forest conditions, and harvest intensity levels. The approach is described, functional form of the cost equation is presented and discussed, and initial average costs are summarized based on a small sub-sample of the data.

Introduction

Concerned with the rising damages and suppression costs associated with catastrophic wildfire, the United States General Accounting Office called for a cohesive strategy of fuel reduction treatments to control excessive losses to wildfires. The federal Comprehensive Strategy and Implementation Plan were the two principal USDA Forest Service and Department of Interior responses. In addition, the president and Congress have encouraged fuel treatments through the Healthy Forests Restoration Act, National Fire Plan, and Healthy Forests Initiative. All of these initiatives propose greatly increasing the amount of fuel reduction treatments, including prescribed fire and mechanical approaches. In some cases, mechanical fuel treatments involve the removal of marketable timber products.

Mechanical fuel treatments are different from typical harvests because they involve partial cutting, with small diameter materials requiring the most effort and larger diameter materials the least; in that sense, they are similar to thinning operations. Many of the proposed mechanical treatments may be on steep sites, so their expense per unit of material removed is likely to be different from typical silvicultural treatments. This will affect the net costs of these treatments. The removal of products also will result in impacts on the local and regional timber markets by potentially increasing the supply of some products to mills. This will influence the price of products at the mill, which will in turn affect the net returns to the landowner.

As part of a large research project, the USDA Forest Service Southern Research Station is developing a model that will determine the optimal allocation of fuel treatments across fire prone

[1] Ph.D. student and Professor, respectively, North Carolina State University Department of Forestry and Environmental Resources, Raleigh, North Carolina, USA 27695-8008, raarriag@ncsu.edu and fred_cubbage@ncsu.edu, and Research Economist, USDA Forest Service, Research Triangle Park, NC 27709, kabt@fs.fed.us

regions of the United States. This model is estimating the appropriate mix of treatments across space and over time and the amount of subsidy that the government will need to provide to reduce forest fuel loads and their eventual wildfires. Determining harvest costs for these treatments for all regions and forest types of the U.S. is part of this larger project.

Previous studies of products available from fuel treatments (Fried 2003) have focused on very specific locations (SW Oregon, Sierra Nevada). These projects all used FIA data at the plot level combined with the use of the Forest Vegetation Simulator and either assumptions or the use of ST Harvest to develop harvest costs for each plot and treatment type. Given the scope of the proposed work (all FIA plots in the West), this approach was not feasible. Instead, we developed a new approach described below.

Methods

Harvesting costs are affected by many factors, including tree species, terrain, tree size, stand volume, equipment type, and labor skills (Cubbage et al.1989, Carter et al. 1994, Kluender et al. 1998, Keegan et al. 2002). There are several harvest cost models in use for different regions of the country and different types of timber and harvesting techniques. For the purposes of this study, ST Harvest was used to estimate fuel treatment costs.

This research investigated the effects of several factors, including tree size, tract volume and removal intensity on harvesting costs for applying fuel treatments to Forest Inventory and Analysis (FIA) plots in 12 states located in the Western United States. Ground and cable-based harvesting systems were included and their costs were estimated using ST Harvest (Hartsough 2001). Regression analysis was then used to develop cost equations to predict harvesting costs for each system as a function of tree size, location, tract volume, tree density and removal intensity.

Both whole-tree (WT) and log-length systems were included in the empirical analysis of the harvesting costs for applying fuel treatments to FIA plots using ST Harvest. The six harvesting systems included in this analysis are shown in Table 1 together with the conditions under which they customarily operate. In the whole-tree harvesting method, the tree is felled and delivered to the landing with limbs and tops attached to the stem. In the short-wood or log-length method, trees are processed at the stump. Figure 1 illustrates the steps and activities at each phase of harvesting for both systems.

ST Harvest (Hartsough et al. 2001) was used to estimate production and costs of the six harvesting systems shown in Table 1. The ST harvest computer application is Windows-based, public-domain software used to estimate costs for harvesting small-diameter stands or the small-diameter component of a mixed-sized stand (Fight et al. 2003). This program estimates costs of harvesting small trees in stands in the interior Northwest. ST Harvest provides production functions for harvesting as part of the simulation package, and allows users to use the default costs or update those costs. Equipment prices in the model were updated with current prices from the Green Guide (2005). Table 2 shows the assumptions included in ST Harvest to estimate harvesting costs in this study.

Table 1. Ground-based or cable systems and condition to operate

Tree size and slope	Manual Felling: Ground based: Whole tree length	Manual Felling: Ground based: Log length	Manual Felling: Cable: Log length	Mechanical felling: Ground based: Whole tree length	Mechanical felling: Ground based: Log length	Mechanical felling: Cable: Log length
Maximum tree size (ft^3)	150	150	150	80	80	80
Minimum tree size (ft^3)	1	1	1	1	1	1
Maximum slope (%)	<40	<40	>40	<40	<30	>40

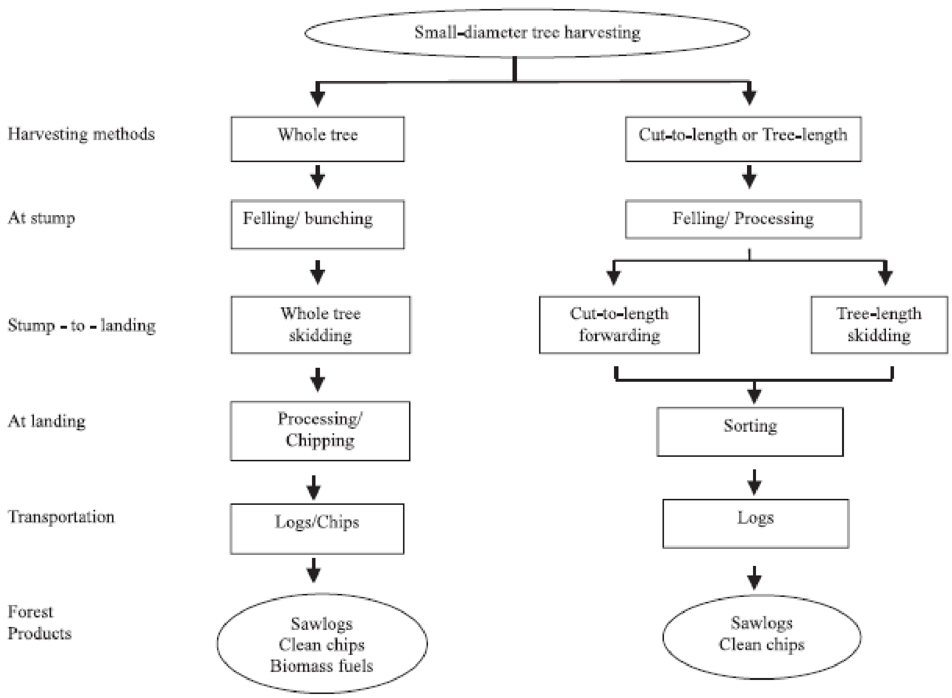


Figure 1. Flow chart of small wood harvesting in whole-tree and cut-to-length/tree-length operations (Han-Sup et al. 2004)

The FIA data plots represented typical forest conditions in the West. The harvesting scenarios for these plots were based on research by colleagues at the USDA Forest Service Southern Research Station and Pacific Northwest Research Station. The Forest Service researchers developed forest harvesting rules that would be appropriate for reducing the risk of forest fires, by limiting spread along the crown and crowning--the spread of fires from the ground to the crown of the trees. They then provided these harvesting rules and scenarios to us, along with sets of summarized FIA plot level data (Huggett 2005, personal comm.). We then used the ST Harvest spreadsheet simulator to estimate harvesting costs for these FIA plots based on tree density conditions, the amount of material to be harvested, and the harvesting systems that would be appropriate for the slope conditions of that FIA plot. We had more than 30,000 FIA plots so needed automated methods to run all the harvest simulations. We were able to obtain a ST Harvest front-end simulator from Bruce Hartsough (personal comm. 2005; Chalmers et al. 2003), which was then used to be able to run the 30,000+ FIA plot harvest simulations swiftly.

Table 2. Assumptions used in ST Harvest to estimate harvesting costs for applying fuel treatments to FIA plots

Variable	Unit	Value
Logging system	---	Whole-tree and log-length harvesting methods, ground based and cable yarder
Cut type	---	Partial cut
Yarding distance	Feet	800
Slope	%	Range from -1% to 85%
Move-in distance	Miles	50
Harvested area	Acres	50
Removal intensity	Cut trees/acre	Range from 0 to 4,682
Tree size	DBH class	d3 < 5" d6 = 5"-6.9" d8 = 7"-8.9" d10 = 9"-10.9" d12 = 11"-12.9" d14 = 13"-14.9" d15 = 15"+"

The FIA plots provided a large sample of conditions in the West and an excellent means to estimate basic regression equations of timber harvesting costs by important variables. Once production rates and costs were estimated using ST Harvest a set of regression equations were estimated to develop an average of harvest costs for the 12 states included in this study. The method of least squares was used to fit a prediction equation of harvesting costs to the data.

Selection of functional form for the timber harvesting cost equations was based on knowledge of timber harvesting operations, past studies, and statistical procedures. In general, timber harvesting is very expensive for small stands and small stems, since it takes many actions with expensive equipment and labor to harvest a small amount of volume. This characteristic has been estimated quantitatively in several studies, which have found that timber harvesting costs are much greater for small stems and for small tracts, and decline asymptotically to a minimum level at large stem size and tract size.

We estimated harvesting costs per dbh class using the following functional form:

$$\begin{aligned}&\ln(\text{harvesting cost per acre and per dbh class}) = \beta_0 + \beta_1\,\text{DBHSm} + \beta_2\,\text{DBHMed} + \beta_3\,\text{Arizona} +\\ &\beta_4\,\text{California} + \beta_5\,\text{Colorado} + \beta_6\,\text{Idaho} + \beta_7\,\text{Montana} + \beta_8\,\text{Nevada} + \beta_9\,\text{New Mexico} +\\ &\beta_{10}\,\text{Oregon} + \beta_{11}\,\text{South Dakota} + \beta_{12}\,\text{Utah} + \beta_{13}\text{Washington} + \beta_{14}\,\ln(\text{total volume per acre}) +\\ &\beta_{15}\,\ln(\text{trees removed per acre}) + \beta_{16}\,\ln(\text{trees per acre}) + \beta_{17}\,\text{Slope} +\\ &\beta_{18}\,\ln(\text{trees removed per acre}) * \ln(\text{trees per acre}) + \varepsilon\end{aligned}$$

where ln is the natural log, harvesting cost is measured in $US per acre, per plot and per dbh, DBHSm is a dummy variable taking on the value of one for trees with DBH less than 6.9 inches, DBHMed is a dummy variable taking on the value of one for trees with DBH between 7 and 12.9 inches and total volume removed per acre is measured in cubic feet. The western states included in the data frame were Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington and Wyoming. Table 3 shows the descriptive statistics of the variables included in this analysis.

Table 3. Descriptive statistics of independent variables included in cost analysis

Variable	Description	Mean*	Standard deviation	Coefficient of variation (%)
TOTVOL	Total volume removed per acre (ft^3/acre)	546.45	706.63	129.20
TREEACRE	Number of trees per acre	147.60	222.69	150.86
TREEREM	Number of trees removed per acre	86.67	147.26	169.89
SLOPE	Slope (%)	25.43	21.93	86.23
DBHSM	Dummy variable for small trees = 1 if DBH is less than 6.9 inches	0.43	0.49	---
DBHMED	Dummy variable for medium trees = 1 if DBH is between 7 and 12.9 inches	0.42	0.49	---
ARI	Dummy variable for region = 1 if state is Arizona	0.017	0.129	---
CAL	Dummy variable for region = 1 if state is California	0.172	0.377	---
COL	Dummy variable for region = 1 if state is Colorado	0.208	0.406	---
IDA	Dummy variable for region = 1 if state is Idaho	0.086	0.280	---
MON	Dummy variable for region = 1 if state is Montana	0.096	0.294	---
NEV	Dummy variable for region = 1 if state is Nevada	0.001	0.033	---
MEX	Dummy variable for region = 1 if state is New Mexico	0.033	0.179	---
ORE	Dummy variable for region = 1 if state is Oregon	0.185	0.388	---
SDA	Dummy variable for region = 1 if state is South Dakota	0.002	0.053	---
UTA	Dummy variable for region = 1 if state is Utah	0.022	0.147	---
WAS	Dummy variable for region = 1 if state is Washington	0.140	0.347	---

* Including 34,595 records of 12,039 plots located in twelve states in the West

This functional form allows one to use the results without needing to know the units of measurement of variables appearing in logarithmic form, because the slope coefficients are invariant to rescaling. Moreover, by using ln(harvesting cost per acre and per dbh class) as the dependent variable we can satisfy the Classical Linear Model (CLM) assumptions more closely. Strictly positive variables (as is the case for harvesting costs) often have conditional distributions that are heteroskedastic or skewed; taking the log can mitigate both problems. There are also some standard rules of thumb for taking logs. When a variable is a positive dollar amount, the log is often taken.

A high coefficient of variation was associated with total volume removed per acre, number of trees per acre, and number of trees removed per acre as related to the different fuel treatment scenarios and the different geographical locations of the 12,039 FIA plots. This permitted us to estimate a robust and very representative harvesting cost function that can be applied to different treatment scenarios and locations.

For the case of the dependent variable, harvesting costs in dollars per acre were estimated for the 34,595 records, which included the six ground-based and cable harvesting systems included in this analysis. Table 4 shows the harvesting costs included in this study as the dependent variable, which were obtained using ST Harvest. Table 4 shows high coefficient of variations for all harvesting systems given that dbh classes go from small diameter trees to larger diameter tress which affects fuel treatment costs. The variation is also explained for the application of different harvesting systems under different conditions of tree density and with different harvesting intensities. And again, as was the case for the independent variables shown in Table 3, the high coefficient of variation of harvesting costs shown in Table 4 is also explained by different slope conditions and plot location.

Table 4. Descriptive statistics of harvesting costs per acre and per dbh class obtained with ST Harvest and included in cost analysis

Variable	Description	Mean	Standard deviation	Coefficient of variation (%)
MANWT	Cost of ground-based manual whole tree harvesting system ($/acre/dbh)	1,274$^{(1)}$	1,029	80.77
MANLOG	Cost of ground-based manual log harvesting system ($/acre/dbh)	1,905$^{(1)}$	1,450	76.12
MECHWT	Cost of ground-based mechanical whole tree harvesting system ($/acre/dbh)	1,032$^{(1)}$	1,110	107.56
CTL	Ground-based cut to length harvesting system ($/acre/dbh)	1,364$^{(2)}$	1,287	94.35
CABLEMAN	Cost of cable manual log harvesting system ($/acre/dbh)	5,876$^{(3)}$	6,412	109.12
CABLECTL	Cost of cable cut to length harvesting system ($/acre/dbh)	5,250$^{(3)}$	5,691	108.40

$^{(1)}$ Including 26,319 records of 9,466 plots located in twelve states in the West
$^{(2)}$ Including 22,306 records of 8,178 plots located in twelve states in the West
$^{(3)}$ Including 8,275 records of 2,573 plots located in twelve states in the West

Results

Using functional form presented in (1) and the information on harvesting costs obtained from ST Harvest and shown in Table 4, Table 5 shows the results of the parameter estimates of the harvesting cost function for fuel treatments of FIA plots for a ground-based manual whole-tree harvesting system. We also have preliminary results for five other harvesting systems listed in Table 4, but so not have space here to summarize them all. Thus this system is used to illustrate the approach, and details on the other systems will be published later or become available from the authors as final results are estimated.

Table 5 shows that the dummy variable for Arizona (ARI), California (CAL), Idaho (IDA), Nevada (NEV), New Mexico (MEX), Utah (UTA) and Washington (WAS) were not significant at the 5% level. All the rest of the independent variables were significant at least at the 5% confidence level after correcting for heteroskedasticity. These dummy variables thus shift the intercept of the cost equations up or down by state. When log(y) is the dependent variable in a model, as it is the case for the functional form presented in (1), the coefficient on a dummy variable, when multiplied by 100, is interpreted as the percentage difference in *y*, holding all other factors fixed.

We used three broad DBH classes in estimating the regressions of harvesting costs, by collapsing the 7 original classes described in Table 2 into only three dummies: small, medium, and large. To avoid problems with rank conditions in the regression estimation, the effect of the large tree dbh class is contained in the constant of the regression, which is significant. The coefficients on dbh class β_1 and β_2 gives the approximate proportional difference in harvesting costs per acre for those small trees (dbh less than 6.9 inches) and medium trees (dbh between 7 and 12.9 inches), respectively. This implies that the coefficient on DBHSM gives the approximate proportional differential in harvesting costs between those who are and are not small trees. In this case, the coefficient on DBHSM is .064, thus the harvesting costs are 6.4% higher for small trees than large trees, holding medium size tree, state, total volume, removal intensity, trees per acre and slope constant. Similarly, for this case harvesting costs are 8.1% lower for medium size trees than large trees, holding small tree size, state, total volume, removal intensity, trees per acre and slope constant. This indicates that both small and large trees are more costly to harvest given the typical equipment used in ground-based manual systems for fuel treatment harvests.

The coefficients on the different states included in this study give the proportional change in harvesting costs per acre between those trees that are and are not located in each one. For the case of Colorado for example (COL), harvesting costs per acre are 3.2% higher holding constant dbh class, other states, total volume per acre, removal intensity, trees per acre and slope. Coefficients on LNTOTVOL, LNTREEREM and LNTREEACRE were very significant in predicting harvesting costs per acre. For these cases β_{14}, β_{15} and β_{16} represent the elasticity of harvesting costs per acre with respect to total volume per acre, removal intensity and number of trees per acre respectively. According with Table 5, when TOTVOL, TREEREM and TREEACRE increases by 1%, harvesting costs increase by approximately 0.41%, decrease by 0.49%, and increase by 0.52% respectively holding constant tree size, state and slope.

The coefficient β_{18} measures the impact on harvesting costs per acre based on the interaction between trees per acre and number of trees removed per acre. In this case, the interaction was very significant. One would expect this result since the interaction variable is measuring the fuel treatment effect on the selection of removal intensity. In this case, the effect of one unit change in trees per acre will depend on the level of number of trees removed per acre and vice versa. When trees per acre or removal intensity changes by 1%, the interaction term makes increase harvesting cost per acre by 0.050%. β_{17} is the semi-elasticity of harvesting costs per acre with respect to slope. When slope increases by 1%, harvesting costs per acre increases approximately by 0.60%.

Table 5. Estimation of the harvesting cost function for applying fuel treatments to FIA plots in twelve states in the West using a ground-based manual whole tree harvesting system

Independent variables	**Parameter**	**Estimated coefficient (OLS)**	**Standard error**	**P-value**
Constant	β_0	2.484	0.023	0.000
DBHSM	β_1	0.064	0.013	0.000
DBHMED	β_2	-0.081	0.007	0.000
ARI	β_3	-0.006	0.008	0.442
CAL	β_4	-0.003	0.006	0.625
COL	β_5	0.032	0.005	0.000
IDA	β_6	0.005	0.006	0.395
MON	β_7	-0.034	0.006	0.000
NEV	β_8	0.020	0.022	0.363
MEX	β_9	-0.009	0.007	0.171
ORE	β_{10}	-0.011	0.005	0.029
SDA	β_{11}	-0.046	0.013	0.001
UTA	β_{12}	-0.016	0.009	0.071
WAS	β_{13}	0.003	0.005	0.598
LNTOTVOL	β_{14}	0.408	0.005	0.000
LNTREEREM	β_{15}	-0.486	0.003	0.000
LNTREEACRE	β_{16}	0.515	0.006	0.000
SLOPE	β_{17}	0.006	0.000	0.000
LNTREEACRE*LNTREEREM	β_{18}	0.050	0.000	0.000
N	26,319			
R^2	0.969			
Adjusted R^2	0.969			
F-value	45,492			0.000

The model estimated and presented in Table 5 was very significant (P-value < 0.000) and explained 96.9% of the variation in harvesting costs per acre for applying fuel treatments to FIA plots. Much of the significance can be attributed to the large sample size, but the large coefficient of determination also indicates the model fit the harvesting cost data well. The results for the calculations shown in Table 5 were illustrative of the process, but may need adjustment for move-in costs in future research. ST Harvest gives cost estimates for specific combinations of removal intensities and tree volume. For complete estimates of costs per plot, one has to weight the different combinations of tree removal intensity and tree volume for every plot. These weights were proxied by the ratio between trees removed per dbh class and total number of trees removed for each plot included in this study. The comparative findings about the importance of the variables affecting costs remain unchanged. Preliminary results for other timber harvesting systems and equipment configurations were calculated, although revisions remain in progress.

To provide more accessible results of the weighted costs for this paper, a sample of 20 plots was used and the mean and standard deviations of timber harvesting costs were calculated (Table 6).

Table 6. Sample Fuel Harvesting Cost Calculations per Acre for FIA Plots for Four Ground-Based Systems in the West, U.S. Dollars, 2005

System	Mean ($/acre)	Standard Deviation	Coefficient of Variation (%)
Manual Whole-Tree	740	455	61.49%
Manual Log	1,136	748	65.85%
Mechanical Whole-Tree	552	278	50.36%
Cut-to-Length	699	351	50.21%

Conclusions

For our preliminary results from the 20 plot samples, the mean fuel harvesting costs based on our regression equation estimates ranged from $552 per acre to $1,136 per acre. Mechanical whole-tree harvesting operations were cheapest on average, followed by cut-to-length and manual-whole tree. Variations in the cost estimates are again partly explained by the different harvesting system applied, slope condition, plot location, tree density condition and removal intensity defined for every dbh class.

Several preliminary conclusions can be made as a result of this study. Considering a ground-based manual whole tree harvesting system, dbh class, state (Colorado, Montana and South Dakota), tract volume, trees per acre and removal intensity appear to be the most statistically significant variables that explain the variation in harvesting costs per acre. Regarding with a ground-based manual log harvesting system, dbh class, state (Colorado, Montana and Washington), tract volume, trees per acre and removal intensity were the most statistically significant variables that explain the variation in harvesting costs per acre. For the case of a ground-based mechanical whole tree harvesting system, dbh class, state (Colorado, Montana and Oregon) were the most statistically significant variables in explaining cost variation.

For the cut to length harvesting system, small trees size (dbh < 6.9"), state (Colorado and Montana), tract volumes, trees per acre and removal intensity were the most statistically significant variables that explain the variation in harvesting costs per acre. For the case of the cable-based harvesting systems, only small trees size (dbh < 6.9"), tract volumes, trees per acre and removal intensity were the most statistically significant variables to help to explain the variation in harvesting costs per acre. For these harvesting systems plot location was not significant.

Slope was statistically significant no matter which harvesting system was selected, although its impact on costs was small. The impact of slope on cost was large only for the case of a ground-based mechanical whole tree harvesting system, where a 1% increase in slope caused a 1.3% increase in harvesting cost per acre. Regardless of harvesting system, costs tend to decrease when total tract volume and removal intensity increase. The opposite trend is observed when initial trees per acre increase.

This research provides considerably more information about timber harvesting costs for fuel reduction treatments. It developed a method to estimate timber harvest costs for fuel treatments in the West based on existing harvesting technologies, an existing western timber harvesting simulation package, and extensive FIA plot level data for 12 western states. Our results are preliminary since this is still a work in progress. The results do indicate that fuel harvesting costs are expensive. Fuel reduction harvests take out a large share of small stems, using either expensive equipment or lots of manual labor, often on steep terrain. This is far less economically efficient than harvesting fewer large trees with much more volume, which is typical of normal sawtimber harvests in the West.

Providing much better estimates of these fuel reduction harvest costs can help managers plan how to allocate their budgets and forest and homeowners decide how to protect their property. We will continue these analyses and discuss their implications more as this research proceeds.

References

Carter, Douglas R., Frederick W. Cubbage, Bryce J. Stokes, and Pamela J. Jakes. 1994. Southern pulpwood harvesting productivity and cost changes between 1979 and 1987. Research Paper NC-318. U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. St. Paul, MN. 33 p.

Chalmers, S., B. Hartsough, and M. deLausaux. 2003. Development of a GIS-based Tool for Estimating Supply Curves for Forest Thinnings and Residues to Biomass Facilities in California. Final Report. Department of Biological & Agricultural Engineering, UC Davis, California.

Cubbage, Frederick W., W. Dale Greene, and John P. Lyon. 1989. Tree size and species, stand volume, and tract size: effects on southern harvesting costs. Southern Journal of Applied Forestry 13(3):145-152.

Fight, R., Zhang, X. and Hartsough, R. 2003. Users guide for STHARVEST: software to estimate the cost of harvesting small timber. Gen. Tech. Rep. PNW-GTR-582. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 12p.

Fried, J.S., J. Barbour and R. Fight. 2003. FIA BioSum: Applying a multi-scale evaluation tool in Southwest Oregon. Journal of Forestry 101(2):8.

Green Guide. 2005. Green Guide Equipment Values. https://www.equipmentwatch.com/Marketing/GG_overview.jsp

Han-Sup, H., Lee, H. and Johnson, L. 2004. Economic feasibility of an integrated harvesting system for small-diameter trees in southwest Idaho. Forest Products Journal 54(2): 21-27.

Hartsough, Bruce. 2005. ST Harvest block data input file program. University of California, Davis. Personal communication.

Hartsough, B. Zhang, X. & Fight, R. 2001. Harvesting Cost For Small Trees in Natural Stands in the Interior Northwest. Forest Products Journal. 51(4):54-61

Huggett, Robert. 2005. Forest Inventory and Analysis (FIA) plot-level data summaries for 12 western states. USDA Forest Service, Southern Research Station. Personal communication.

Kluender, R., D. Lortz, W. McCoy, B. Stokes, and J. Klepac. 1998. Removal intensity and tree size effects on harvesting cost and profitability. Forest Products Journal 48(1):54-59.

Keegan III, C. et al. 2002. Harvest cost collection approaches and associated equations for restoration treatments on national forests. *Forest Products Journal* 52(7/8): 96-99.

SOFEW_fuel_harvest_V4; 2 January 2006

Concurrent Session 4B: Survey Studies II

Vegetation Management on Private Property in the Wildland-Urban Interface: The Role of State Governments

Margaret A. Reams, Terry K. Haines, and Cheryl R. Renner

ABSTRACT

In response to the increased threat of catastrophic wildfire, states have adopted various policies and programs to reduce hazardous fuels and protect communities. Many of these programs offer public education and assistance to private property owners concerning vegetation management. Some states have adopted regulations to compel residents to adopt fuel management practices. In 2003, researchers surveyed state and local administrators of wildfire risk reduction programs in 25 states. The current study analyzes the responses of 20 state-level administrators in 16 states along with information the authors collected about these programs in creating the website www.wildfireprogram.usda.gov. The authors present an overview of the structure and objectives of state-level programs for reducing hazardous fuels on private lands; and potential obstacles to program effectiveness, such as budget shortages, inadequate cooperation among agencies, and public resistance. Also, states with more complex programs are identified and the authors examine contextual factors that may influence formulation of more ambitious risk reduction efforts.

KEYWORDS: *Wildfire risk reduction; state programs*

Contact: Margaret Reams, LSU Department of Environmental Studies; Energy, Coast and Environment Bldg., Baton Rouge, LA 70803; (225) 578-4299 or mreams@lsu.edu

Terry K. Haines, Southern Research Station, USDA Forest Service, 701 Loyola Avenue, Room 10034, New Orleans, LA 70113

Cheryl R. Renner, 9346 Wellington Park Circle, Tampa, FL 33647

ACKNOWLEDGMENTS

This research is supported by a cooperative agreement between the USDA Forest Service, Southern Research Station, Evaluation of Legal, Tax, and Economic Influences on Forest Resource Management (4802) and Louisiana State University. The authors thank James E. Granskog, Project Leader, for his valuable suggestions and input.

Vegetation Management on Private Property in the Wildland-Urban Interface: The Role of State Governments

Introduction

Residential expansion into the Wildland-Urban-Interface (WUI) has placed property, natural assets and human life at risk from wildfire destruction. Wildfires in 2000 and 2002 were particularly devastating, with a total of more than 15 million acres burned and nearly 1700 homes destroyed (National Interagency Fire Center, 2004). Furthermore, California suffered its worst wildfire season in modern times in 2003 with more than 739,000 acres burned and 3,600 homes lost (U.S. Department of Agriculture, 2004).

The U.S. National Fire Plan encourages states, counties and municipalities to implement laws and outreach programs for pre-fire planning to mitigate the risk to area residents. Many of these risk mitigation programs are listed on the USDA Forest Service's National Wildfire Programs website, www.wildfireprograms.usda.gov, a catalog of state and local programs to reduce hazardous fuels in and around Wildland-Urban Interface (WUI) communities using vegetation management, primarily on private lands. Since many of these state-level programs are relatively new, it is useful to examine their objectives and activities. Insight into more effective strategies for risk reduction is important to public policy theorists, public decision makers, and community stakeholders.

Our research objectives are two-fold. First, we report on current state programs, describing stated objectives, activities, and managers' perceived obstacles to program effectiveness. Second, we examine the potential influence of socioeconomic conditions and population growth rates on the complexity and activity levels of the state-level wildfire reduction programs.

Encouraging Property Owners to Reduce Risk

One of the challenges facing decision makers as they formulate state and local risk mitigation programs is how to change the behaviors of private property owners regarding vegetation management. While there is substantial scientific research concerning components of wildfire risks, such as the relative influences of climate, topography, and fuel loadings, there is far less research concerning related human behavior and the types of programs most likely to lead to desirable changes in that behavior. The strategies employed by risk reduction programs targeted to private property owners remain largely untested.

Public risk perceptions concerning wildfire appear to affect residents' support for policy alternatives to mitigate the risk. For example, Bradshaw (1987) and Loeher (1985) reported that many residents within WUI communities had had no direct experience with the devastating effects of wildfire and, as a result, tended to underestimate the risk. Even those who have experienced a disaster in the past and have survived, often fail to recognize the risk of a future event (Halpern-Felsher et al 2001). Working with focus groups in Michigan, Winter and Fried (2000) found that wildfire is perceived to be inherently uncontrollable, with random patterns of damage; a perception that tended to discourage individual property owners from engaging in unilateral removal of vegetation. Further, they found that regulations such as zoning and safety ordinances for vegetation management might be viewed as unacceptable infringements on the rights of property owners to use their property as they see fit. On the other hand, support for more restrictive government regulations seems to increase after a community has experienced a wildfire (Abt et al., 1990).

Similarly, Mileti and Peek-Gottschlich (2001) found that risk perceptions might be influenced by cultural identity and values. Residents may not support vegetation management because they fear that removal of trees and shrubs will negatively affect the aesthetics and ecological functions of a natural landscape (Alan Bible Center for Applied Research 1998; Hodgson 1995; Davis 1990). Winter and Cvetkovich (2003) found that the public tends to support fuel management strategies implemented by the Forest Service when they believe that the agency's values are consistent with their own. Further research by Winter et al (2004) in California, Michigan and Florida found that while agency trust varied geographically, trust to make decisions regarding defensible space ordinances was lower than trust to make decisions about prescribed burning or mechanical treatment in general. The Winter and Fried (2000) and Winter et al (2004) findings suggest that while public support may be weaker for regulations, it may be stronger for educational and assistance programs that raise the awareness of the wildfire threat, teach specific methods for fuel reduction, and encourage a coordinated set of mitigation actions among community residents.

Given the various constraints on residents' willingness to implement vegetation management strategies, a clear role exists for effective risk reduction programs. Existing efforts tend to take the form of direct regulations at the state, county or municipal levels or more voluntary, public-outreach type programs. This research is an initial step in gaining insight into what state-level programs are attempting to accomplish, how they are going about furthering their goals, and the obstacles their administrators are encountering as they attempt to reduce risk to WUI communities from catastrophic wildfire.

Data and Methods

The research proceeded in two stages. First we developed the National Wildfire Programs Database website, cataloging state and local wildfire risk reduction programs. The objective of the database website, www.wildfireprograms.usda.gov is to facilitate broad dissemination of ideas among fire protection officials, community leaders, policy makers, planners, educators, and homeowners by creating a clearinghouse of information about wildfire mitigation programs across the country. By summer 2003 we had identified roughly 150 programs in 25 states, and were continuing to build the database.

The website information gave us an overview of program structure and type, and allowed us move to the second phase of research wherein we surveyed the administrators of the programs listed on the website to elicit additional information about their efforts. We used information gleaned from our prior work in creating the website's program summaries to inform survey questions about potential program activities and obstacles that administrators may be facing. We did not attempt to construct a sample of the programs listed on the website; our intent was to gather information about the entire group. The survey was concise and respondents could simply fill in their answers and send the completed survey by reply e-mail. We e-mailed 100 surveys and received completed surveys from 56 managers.

In some cases, the same individual had responsibility for several initiatives described as separate programs on the website, and combined his or her responses into one questionnaire. In other cases, managers of programs did not respond, even after two follow-up e-mail requests. We compared the list of non-responders with the managers who did respond in an effort to determine possible bias in the responses. The non-responders were evenly distributed among the various types of risk reduction programs, indicating no significant response bias in the survey.

We analyzed the administrators' responses and examined possible influences of socioeconomic conditions and rates of population growth on state-level program complexity. We included the following data from the 2000 U.S. Census Bureau: state population growth from 1990 – 2000; percent of residents with at least a college degree, and; per capita income. We used descriptive statistics, difference of means tests, and Pearson Correlation analyses in SPSS Version 11.5 to analyze the data.

Survey Results: Program Goals

Education. We found that all state programs in the study conducted at least some activities designed to enhance the public's awareness of wildfire hazards and specific risk reduction strategies. We provided respondents with a list of potential program activities and asked them to place a check mark beside each activity they conduct. Also, we provided a blank line and asked respondents to write in any of their outreach activities not listed.

Respondents use a number of methods to educate the public about the dangers of living in wildfire-prone areas, and to convince property owners of the importance of creating defensible space around their homes. Publications that promote hazard reduction, fire protection and safety, as well as landscaping and defensible space guidelines specific to the geographic area have been developed and distributed through mailings, public events, and on websites. Lists of recommended fire-resistant plant species have been developed and disseminated, particularly in new residential developments. Publicity in newspapers, on radio, television and through videos which discuss wildfire protection, hazard reduction planning, and thinning projects are other activities designed to educate the public. Classroom resources and teacher training are part of the overall education component in many of the jurisdictions. In several states, a fire science component has been added to the science curriculum to inform students about wildfire ecology, safety and protection.

Fire protection officials have developed their own classroom programs in many areas. These efforts have included "hands on" defensible space and fire safety programs for grade school students. Those targeting high school students have involved fuels removal around schools and field exercises, such as assessment and mapping of high fire-risk areas in the community.

Fire officials are also conducting community and neighborhood meetings. In these meetings a dialogue between residents and fire officials is established and issues related to wildfire protection measures for the area are explored. In addition, wildfire management officials are also promoting firewise workshops for volunteer and career firefighters, planners, developers, and policy makers. The workshops generally focus on developing a wildfire risk management plan for the town or community. While the specific activities designed to educate the public may vary, the median number of outreach activities for the state-level programs is 12.

Risk Assessments. State and local wildfire risk assessments and mapping projects are underway, or had been completed by 2003 in 13 of 17 state-level programs. Designation of high-risk areas is accomplished by assessing the interaction of individual risk factors such as fuel loading, topography, fire history, climate, housing density, and infrastructure for fire fighting. Inspections by trained personnel using a wildfire hazard severity rating system to determine risk for individual homes and subdivisions were being used in 44 localities. Hazard severity rating systems used are often based on a model developed by the National Fire Protection Association in NFPA 299. This model was adapted for individual states by several state fire protection organizations. The model assigns a rating for individual components of wildfire risk related to vegetation, home construction materials, road design and access, water availability, signage, and other factors. From these ratings, a composite hazard severity score is assigned (NFPA 1997). The state program administrators report using, on average, two risk assessment models regularly to help better understand and determine areas of highest risk within their states.

Homeowner Assistance. Direct assistance to homeowners was reported as a program objective by 47 of the managers surveyed, including 16 of the 17 state-level programs administrators. We presented a list of common homeowner assistance services and asked the respondents to place a check mark beside all that apply to their program, as well as to write in any other assistance activities not listed. Those jurisdictions offering homeowner assistance usually provided a combination of services, such as home inspections, free prescriptions, cost-share or free clearing and chipping or disposal of debris. Despite the high cost of land treatment for homeowners, 18 jurisdictions provide free defensible space clearing assistance to homeowners, and 28 of respondents offer assistance on a cost-sharing basis. Other popular assistance activities include free chipping of debris in 27 jurisdictions, and free slash disposal in19 jurisdictions. Many jurisdictions have instituted regular curbside pickup and/or established community disposal sites. Among the 17 state programs reviewed here, administrators have implemented an average of three on-going services or activities to help private property owners adopt and maintain vegetation management.

Direct Regulation States may require the reduction of vegetative fuels around structures through statewide requirements and/or by encouraging ordinances at county and municipal levels of government. These ordinances are based on the police powers granted to states by the constitution, to protect the health, safety and welfare of its citizens. States delegate this power as it relates to land use to local government entities. The unit of government closest to the people is thereby empowered to adopt, administer and enforce regulations designed to control private behavior for the public good.

In our research for the website we found that states took differing approaches to regulating defensible space. Two states, California and Oregon, have statewide ordinances that require fuels reduction in high hazard areas. Several other states, including: Colorado, Montana, Minnesota, Virginia, and Washington, have issued guidelines to local jurisdictions for adoption at the local level. These guidelines vary from model ordinances provided in adoptable language to schematic design recommendations for spacing houses and trees.

California has the most experience with vegetation management regulations, having adopted its first statewide fire safe regulations in 1982 following fires in San Bernardino, Napa and Los Angeles Counties. These first regulations required classification of land into fire hazard severity zones and applied only to State Responsibility Areas (SRA), areas in which the financial responsibility of preventing and suppressing fires is primarily the responsibility of the state. The first law to specifically address vegetative fuels clearance was Public Resource Code (PRC) 4291 enacted in 1985, applicable only to the SRA. Subsequent regulations including PRC 4290, which includes standards for roads and access, vegetation clearance around structures, signage and building identification, fuel breaks and greenbelts and private water supplies for fire fighting, continued to raise fire safety standards. But wildfire continued to threaten homes and lives in the ever-growing wildland-urban interface.

In 1992, with the adoption of the Bates Bill, fire hazard reduction legislation became applicable to Local Responsibility Areas (LRA), areas where local or federal agencies have responsibility for fire control. The regulations are comparable to those that existed in the SRA since 1985, and brought fire hazard reduction regulations to all high wildfire risk areas throughout the state. Minimum fire safety standards were set forth for local governments to adopt, a wildfire risk assessment of the state was completed in 1995, and model ordinances were drafted. Any jurisdiction with designated Very High Fire Hazard Severity Zones (VHFHSZ) was required to adopt the new standards or show that it had restrictions already in place, which met or exceeds the Bates requirements.

The California Department of Fire Prevention and Forestry is responsible for enforcement of the vegetation management regulations. They employ a force of inspectors to visit homes in VHFHSZ areas and have the authority to fine landowners for failure to comply.

Oregon adopted Senate Bill 360, the Oregon Forestland-Urban Interface Fire Protection Act in 1997, and the rules for administrating the Act were adopted in 2002. The first step for administration of the Act is the classification of properties as Forestland-Urban Interface (FUI). This classification is based on assessment of risk factors for a parcel's local climate, natural vegetative fuels, and topography. The density of dwellings in the area is another risk factor. An appointed county committee participates in the identification of FUI properties. Property owners are notified by the Oregon State Forester of their classification, whether L, M, H, or E, (Low, Moderate, High or Extreme). Owners of properties classified as M, H, or E are required to take actions to mitigate fire hazards.

The program is being phased in slowly throughout the state. In 2003, the Act went into effect for Jackson and Deschutes Counties, as these two counties were deemed to have the highest wildfire hazard risk. Beginning in November 2004, letters were sent out to property owners in Deschutes County notifying them if they are in a Wildfire Hazard Zone. Property owners in Jackson County began receiving letters in January of 2005. Owners will have two years in which to complete the necessary fire risk reduction measures and return a certification form to ODF.

In counties within Oregon where stricter requirements exist, those ordinances will supersede the state law. The Forestland-Urban Interface Fire Protection Act does not supersede more restrictive local regulations. No enforcement measures are included in the regulations at this time. The State Forester will send all owners of urban interface forestland an evaluation form. The form will allow owners to self-assess compliance with the standards. The form does not need to be mailed back to the Forester. When a wildfire occurs on FUI forestland, the Forester will determine whether the ignition or spread of the fire was directly related to the owner's failure to meet the standards. If a landowner is found to have directly caused the wildfire, the costs of suppression of that fire will be assessed to the owner up to $100,000.

Major Obstacles Facing Program Administrators

We were also interested in the extent to which state program officials are experiencing difficulties making progress toward program goals. We asked survey respondents to indicate the major obstacles they face in meeting the goals and objectives of their programs. Respondents examined a list of potential obstacles such as budgetary constraints, inadequate cooperation among relevant public and/or private agencies, and public apathy and were asked to indicate on a scale of 0 – 5, the extent to which the item is an obstacle. If an item is not an obstacle at all, the respondents were asked to put a "0" in the blank. An examination of these scores indicates that the obstacles receiving the highest scores – indicating they are more significant obstacles – are budgetary constraints, public apathy, and property owners' resistance to vegetation removal.

Respondents indicated that the most serious obstacles to the success of their programs have to do with financial resource limitations and negative attitudes of private landowners. Specifically, the perceived obstacles scoring the highest are budget limitations, public apathy, shortages of technical staff, and resistance by property owners to ongoing vegetation management. The state managers' responses suggest that budgetary constraints may be more of an obstacle for them than their counterparts at the county and community levels, with a mean score of 3.9, compared to 3.3 for the managers of local programs. Also, the state administrators reported more concern about the program-thwarting effects of public apathy, an average score of 3.53 compared to 3.14 for sub-state program officials. Similarly, the state officials faced slightly higher obstacles from landowners resisting vegetation management, with this issue receiving a mean score of 3.01 compared to the sub-state managers' rating of 2.89.

Program Differences among the States

We also examined differences in program "complexity", as indicated by more distinct program goals or objectives articulated. For this analysis, we defined "more complex" as those being those programs with four separate objectives and "less complex" programs as those with two or fewer stated goals.

The "More Complex" State Programs are: California, Colorado, Idaho, Minnesota, New Mexico, Utah, Virginia, and Washington. "Less complex" state programs include Arkansas, Kansas, Hawaii, Louisiana, North Dakota, Pennsylvania, South Carolina and Wisconsin.

We were interested in whether certain characteristics of the states may influence program complexity. Specifically, are wealthier states with more highly educated residents more likely to adopt wildfire risk reduction programs that are more ambitious or complex? Also, are those states experiencing larger recent population increases more likely to formulate more complex programs?

In order to explore these questions, we included these contextual factors the in preliminary analyses**: s**tate population growth from 1990 – 2000; percent of residents with at least a college degree; and per capita income. Using a difference of means test, we found some interesting differences between the two groups of states. Those with more complex risk reduction efforts had a slightly better educated citizenry. Twenty-six percent of residents had college degrees or higher, compared with only 22.5% in states with less complex programs. Similarly, the per capita income was higher in states with more complex programs, $23,066 compared to just over $21,000. The biggest difference between the two groups of states concerns population change. The states with more complex programs experienced an average increase of 14.25%, while states with less complex efforts had a much lower average rate of population increase of just 7.5%. Finally, we examined two additional factors that may be associated with program complexity; budgetary constraints and higher overall levels of perceived obstacles facing program officials. Pearson Correlation analyses suggested no significant association between either of these factors and the number of articulated program goals.

Findings and Conclusions

State programs have been adopted and organized to further several fundamental objectives. Those objectives may be categorized as: 1) public outreach and education; 2) assessment of area-wide risks; 3) assistance to private property owners, and; 4) implementation of regulations and standards. Identification of goals allows for creation of an organizational typology whereby programs with similar goals and objectives may be placed into similar categories. This is a useful step, given that eventual discussions of program effectiveness should reflect progress toward specific program goals.

All of the state programs we examined are involved in some type of public education and outreach work, with a mean number of 12 outreach activities regularly offered. Sixteen of the seventeen programs provide assistance to property owners in removal of dangerous vegetation. On average, the state officials offer three fuel reduction services to the public on a regular basis. A third fundamental objective is to determine the wildfire risk facing communities within the state. Thirteen of the state programs engage in large-scale risk characterization using an average of two technical decision aids, such as GIS or fire modeling computer programs. Finally, three of the state programs we examined implement legal standards and requirements for fuel reduction on private lands.

Preliminary analysis suggests several insights into the obstacles faced by administrators of state wildfire risk reduction efforts. First, while they face many of the same obstacles as county and local programs, there are some notable differences. Perhaps, not surprisingly, state officials report more significant difficulties posed by budget-related constraints. This may be because state managers face the larger challenge of affecting the behavior of private landowners across a wider geographic area, in comparison to either county or local jurisdictions. Similarly, state program managers may be more keenly aware of the problems related to public apathy and, thus, attribute more significance to this challenge.

Given the importance of these state risk mitigation efforts, it is helpful to examine the influences that may influence their chances for success. States experiencing larger increases in population appear to have adopted more complex programs, with three or four program goals articulated. Also, more complex risk reduction efforts are observed among states with more highly educated residents. More affluent states with better-educated residents may have an easier time launching more comprehensive risk reduction programs. In light of these early indications of contextual variations, "cookie-cutter" approaches to reduce wildfire risk may not work. Some states may benefit from additional help from the federal government or regional partnerships to develop more effective risk communication and outreach to help win over a skeptical public.

REFERENCES

Abt, R.; Kuypers, M.; Whitson, J. 1990. Perception of Fire Danger and Wildland/urban Policies after Wildfire. P. 257-259 in Proceedings of an international symposium, Fire and the Environment: Ecological and Cultural Perspectives, S. Novdin and T. Waldrop (eds.). USDA Forest Service Southeastern Forest Experiment Station, Knoxville, TN

Alan Bible Center for Applied Research. 1998. Report of the Living With Fire survey results. Under contract to Nevada Cooperative Extension, University of Nevada, Reno. Unpublished.

Bradshaw, W. G. 1987. The Urban/Wildland Interface Fire Problem. Can Social Science Play a Role? People and Fire at the Wildland/Urban Interface (A Source Book) R.D. Gole and H.J. Cortner (eds.) . USDA Forest Service, Washington, D.C.

Dillman, D.A., Tortora, R.D., and Bowker, D. 1998. Principles for Constructing Web Surveys: An Initial Statement. Technical Report 98-50, Social and Economic Sciences Research Center. Washington State University, Pullman, WA.

Dillman, D.A. 2000. Mail and Internet Surveys: The Tailored Design Method. Wiley Press, New York. 283 p.

Halpern-Felsher, B.L., S.G. Millstein, J.M. Ellen, N.E. Adler, J.M. Tschann, and M. Fiehl.2001. The role of behavioral experience in judging risks. Health Psychology 20(2):120-126.

International Code Council, Inc. 2003. International Urban-Wildland Interface Code 2003, International Code Council: Country Club Hills, IL. 48 p.

Loeher, L. L. 1985. Fire Hazard: The Dimension of Resident's Attitude: P. 51-55. in Conference Proceedings Living in the Chaparral of Southern California., K. Radtke (ed.), Mileti, D.S., and L. Peek-Gottschlich. 2001. Hazards and sustainable development in the United States. Risk Management: An International Journal 3(1): 61-70.

National Interagency Fire Center. 2004. National Fire News. www.nife.gov/fireinfo Accessed 10/6/2004.

NFPA. 1997. NFPA 299 Standard for Protection of Life and Property From Wildfire. Quincy, MA. NFPA. 14 p.

U.S. Department of Agriculture and Interior. 2004. Implementation of the Healthy Forest Initiative. Fact Sheet. 3p.

Winter, Greg; Fried, Jeremy S. 2000. Homeowner perspectives on fire hazard, responsibility, and management strategies at the wildland urban interface. Society and Natural Resources, 13:33-49.

Winter, Greg, Vogt, C.A., McCaffery, S. 2004. Examining social trust in fuels management strategies. Journal of Forestry 102(6):8-15.

Winter, P.L., and G.T. Cvetkovich, 2003. A study of Southwesterners' opinions on the management of wildland and wilderness fires – Fire Management Version. Riverside, CA: Pacific Southwest Research Station, USDA Forest Service.

Concurrent Session 4C: Public Forestry Programs

Financial returns of wildlife habitat improvement programs in mid-rotation CRP loblolly pine plantations

Brandon G. Sladek[1], Ian A. Munn[2], L. Wes Burger[3], and Scott D. Roberts[4]

Acknowledgements:
Mississippi State University Forest and Wildlife Research Center
BASF
United States Fish and Wildlife Service (Wildlife and Fisheries Economic Enterprises)
Quail Unlimited
This manuscript is publication #FO308 of the Forest and Wildlife Research Center, Mississippi State University.

[1]Graduate Research Assistant, Department of Forestry, Mississippi State University, Box 9681, Mississippi State, MS 39762. bgs29@msstate.edu (662) 325-8358 (v); (662) 325-8726 (fax).
[2]Professor, Department of Forestry, Mississippi State University, Box 9681, Mississippi State, MS 39762. imunn@cfr.msstate.edu (662) 325-4546 (v); (662) 325-8726 (fax).
[3]Professor, Department of Wildlife and Fisheries, Mississippi State University, Box 9690, Mississippi State, MS 39762. wburger@cfr.msstate.edu (662) 325-8782 (v); (662) 325-8726 (fax).
[4]Associate Professor, Department of Forestry, Mississippi State University, Box 9681, Mississippi State, MS 39762. sroberts@crf.msstate.edu (662) 325-3044 (v); (662) 325-8726 (fax).

Financial returns of wildlife habitat improvement programs in mid-rotation CRP loblolly pine plantations

Abstract

Provisions of the 2002 Farm Bill provide Conservation Reserve Program (CRP) participants greater flexibility to implement mid-contract management activities that encourage wildlife habitat improvement and timber production. Quality Vegetation Management (QVM) is one mid-contract management technique that utilizes the selective herbicide imazapyr and prescribed burning. Financial rates of return and avian community responses (relative abundance, species richness, and total avian conservation value) were evaluated in mid-rotation CRP loblolly pine plantations in two physiographic regions of Mississippi following QVM application. At two years post-treatment, increases in the relative abundance of 6 early successional bird species were detected on treated sites. Although not significant, mean pine growth increment increases were slightly greater on treated plots than on control plots. Previous studies indicated that the value response increases over time, and positive rates of return become statistically significant sometime after year five. The value of timber on treated plots has increased by $22.23 more per acre by year two than on control plots, and if ultimately attributable to the QVM treatment, would partially offset the cost of habitat improvement.

Keywords: imazapyr, prescribed fire, birds

Introduction

Since the late 1950's, several federal programs (e.g., Conservation Reserve phase of the Soil Bank, Forestry Incentives Program) have promoted forest management on private lands (Allen et al. 1996). Although the majority (34 million acres) of land enrolled in the Conservation Reserve Program (CRP) is distributed throughout the Midwestern and Great Plains states, the program has had a tremendous impact on land-use changes in the Southeast as well (Burger 2000). Through February 2005, 3,271,838 acres were enrolled in the CRP across 12 southeastern states (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia) (USDA 2005). In the Midwest, the predominant conservation practice is grass establishment, whereas tree planting has been the most commonly enrolled practice in the Southeast, representing 1,868,893 acres, or 57 percent of the total enrolled acres as of February 2005 (USDA 2005). Pine plantings, either newly established plantations or previously enrolled plantations represent 48 percent of these acres (USDA 2005).

Disturbance-dependent habitats are in decline in the Southeast as many of the land-use changes (urbanization, modernized farming, introduction of exotic and monoculture communities) within these forested systems have resulted in the loss of many early successional habitats (Hunter et al. 2001, Burger 2000). As a result, many bird species dependent on these communities are declining in the Southeast. However, the enrollment of agricultural lands into the CRP has the potential to provide early successional habitat for many regionally declining grassland and shrub-successional bird species. Despite the success of CRP in the Great Plains and Midwest, responses of grassland and disturbance dependent bird species in the Southeast have not been as positive, largely because of the relatively short window of early successional habitat in planted pines and lack of mid-rotation management.

Under the 2002 Farm Bill, mid-contract management practices permitted on CRP lands, include thinning, prescribed burning, disking, herbicide, and interseeding of legumes, and effective February 2004, are now encouraged through cost-share payments (USDA 2003a, USDA 2003b). Quality Vegetation Management (QVM) is a habitat improvement technique that utilizes a combination of the selective herbicide Arsenal® Applicators Concentrate (ArsenalAC) and prescribed burning to improve wildlife habitat and timber production. The application of ArsenalAC during the late growing season controls most lower to midstory hardwood encroachment with minimal long-term effects on forbs and grasses (Hurst 1989). In a study on the effects of using ArsenalAC for pine release, Hurst (1989) found that it was effective for controlling midstory hardwoods, but important wildlife plants such as blackberry, dewberry, greenbrier, and other various legumes recovered quickly following initial setback. Prescribed burns conducted during winter are beneficial for wildlife foods by stimulating prolific sprouting from understory plants and permitting more light to aid herbaceous growth (Chen et al. 1975, Dills 1970).

From plantation establishment until stand maturity, competing vegetation will affect the growth of desired crop trees. Some competition may be beneficial as it helps maintain good tree form and natural pruning; however, substantial competition, usually from other plant species, will negatively affect pine growth through competition for important resources (Schultz 1997). Numerous studies reported significant growth responses to competition control in young pine plantations (Bacon and Zedaker 1987, Creighton et al. 1987, Knowe et al. 1985), and others have demonstrated significant increases in growth with mid-rotation control of competing hardwoods (Fortson et al. 1996, Oppenheimer et al. 1989).

Quality Vegetation Management studies have been conducted in mature (45 - 50 years old) naturally regenerated pine stands (Edwards et al. 2004, Jones et al. 2003) and mid-rotation commercial pine plantations planted on reforested sites (Woodall 2005, Thompson 2002, Hood 2001) in east-central Mississippi, where the hardwood rootstock and seed sources are abundant. In both instances, preliminary results indicate that QVM may improve wildlife habitat quality; however, research is lacking on the effects of QVM on wildlife habitat and timber production in CRP pine plantations, where hardwood competition is largely absent at planting.

Methods

Study Area and Treatments

This study was conducted in the Upper and Lower Coastal Plain physiographic regions of Mississippi. Six study sites (blocks) were located in Kemper (4 sites) and Neshoba (2 sites) counties in East Central Mississippi (UCP) and six study sites were located in Lincoln (3 sites) and Covington (3 sites) counties in southern Mississippi (LCP). Study sites were chosen based on stand age (15-18 years-old), and enrollment in the Conservation Reserve Program. All sites consisted of approximately 45 acres of privately owned, mid-rotation pine plantation which had been thinned prior to the start of the study. There were two treatments at each study site (block), a control, and an ArsenalAC application combined with a winter burn (QVM), which were randomly assigned to 20-acre plots within each study site. On the QVM treated plots, a mixture of 0.5 pounds active ingredient imazapyr, and a surfactant in 20 gallons of total spray solution per acre was broadcast by skidder during October–December 2002, followed by a prescribed burn during January–March 2003. Pre-treatment stand conditions (number of sites (n); quadratic mean diameter, minimum, maximum diameter at breast height; total height; and volume per acre of pine) were similar between QVM and control plots (Table 1).

Table 1--Pretreatment stand conditions (number of sites (n); quadratic mean diameter, minimum, maximum dbh (inches); total height (feet); volume per acre (cubic feet) by treatment in mid-rotation CRP loblolly pine stands in Mississippi, 2003.

Treatment	n	DBHq	(Min-Max dbh)	Total ht	Volume/acre
Control	12	9.3	(2.0-16.6)	56	1889
QVM	12	9.5	(1.7-22.9)	56	1818

No significant differences were found within any of the three variables of interest (DBHq, P=0.80; total height, P=0.93; cubic foot volume per acre, P=0.76) based on measurements recorded prior to the first growing season post-treatment. The dominant understory species across study sites in both the UCP and LCP was Chinese privet (*Ligustrum sinense*), an invasive exotic.

Avian Community Sampling

Avian communities were sampled once in June, twice in July and once in August 2003, and once in May, and twice in both June and July 2004. Ten-minute point counts were conducted from three permanently marked sampling stations within each treatment plot. All surveys were conducted between 5:30-10:30 (CST), and only when Breeding Bird Survey weather conditions were satisfied (Robbins et al. 1986). All birds seen or heard were recorded by appropriate time (0-3 min., 4-5 min., 6-10 min.) and distance (<82 feet, 82-164 feet, >164 feet, flyover) combination. Only individuals within 164 feet were included in the analysis. Point count data were used to estimate relative abundance, species richness, and total avian conservation value (TACV). TACV is an index to the habitat-specific relative conservation value of the avian community. It is estimated by weighting relative abundance measures by Partners in Flight species conservation priority scores and summing across all species that occurred in a stand, forest, or habitat type of interest (Nuttle et al. 2003).

Timber Growth and Volume

At 10 of the 12 study sites, nine permanent 0.05 acre sub-plots were established per 20 acre treatment plot with a spacing of 4 x 5 chains. Due to space limitations at one study site, only six 0.05 acre sub-plots were established within each treatment plot, while at another study site acreage limitations again limited the number of 0.05 acre sub-plots in the control treatment plot to six. All trees [pine and merchantable hardwoods (>4.99 inches at diameter at breast height)] in each sub-plot were marked with an aluminum tag at breast height (4.5 feet). Diameter at breast height (dbh), total height (H), and total merchantable height (MH=height to a 3-inch top, quality permitting) were recorded pre-treatment (February–March 2003), and twice following application of the QVM treatment (post-treatment) during the 2003-2004 and 2004-2005 dormant seasons. Diameter at breast height, total height, and total merchantable height measurements were used to calculate total and merchantable cubic foot stem volume for each stem using the equations from Merrifield and Foil (1967). Annual growth was calculated as the difference in individual stem growth increments between years.

Financial Return Calculations

To evaluate financial returns as a result of application of the QVM treatment, internal rates of return were computed. Treatment costs used were current operational per acre treatment costs at the time of application, and revenues were per acre treatment volume totals multiplied by current chip-n-saw prices. Timber prices used in rate of return calculations were 2004 fourth quarter prices obtained from Timber Mart-South (2004).

Results and Discussion

Avian Community Metrics

Species richness (sprich), total abundance (abundance), and TACV did not differ during either 2003 [sprich ($F_{1,11}$=0.41, P=0.53); abundance ($F_{1,11}$=0.00, P=0.97); TACV ($F_{1,11}$=0.07, P=0.80)] or 2004 [sprich ($F_{1,9}$=1.40, P=0.27); abundance ($F_{1,9}$=1.17, P=0.31); TACV ($F_{1,9}$=2.17, P=0.17)] (Table 2).

Table 2--Mean total abundance, mean species richness, mean total avian conservation value, and standard error by year and by treatment in mid-rotation CRP loblolly pine plantations in Mississippi, 2003-2004.

	2003		2004	
Community indices	Control(SE)	QVM(SE)	Control(SE)	QVM(SE)
Mean total abundance	7.86(0.49)	7.85(0.49)	8.08(0.37)	7.73(0.37)
Mean species richness	4.95(0.25)	4.83(0.25)	5.88(0.23)	5.68(0.23)
Mean total avian conservation value	144.93(9.14)	143.04(9.14)	150.98(8.00)	139.86(8.00)

The observed initial reduction in these community indices was expected as the QVM treatment was anticipated to create a shift in the breeding bird community from one dominated by forest interior and edge species to one dominated by early successional, pine-grassland, and shrub successional species. During this shift in bird communities these parameters will decrease slightly until the desired suite of avian species responds to the vegetative shift back to an early successional vegetative community. By year two no increase or decrease in any of the three avian community indices were observed. However, increases in the relative abundance of several early successional species were observed (Table 3).

Table 3--Significant increases (alpha = 0.05) in the relative abundance of the following target avian species was observed on treated plots, 2003-2004.

Common name	Scientific name
Common Yellowthroat	*Geothlypis trichas*
Downy Woodpecker	*Picoides pubescens*
Eastern Wood-pewee	*Contopus virens*
Indigo Bunting	*Passerina cyanea*
Pine Warbler	*Dendroica pinus*
Summer Tanager	*Piranga rubra*

Timber Growth and Financial Return

Similar studies evaluating growth responses from mid-rotation competition control (Quicke 2002, Shiver 1994) reported gains in timber growth, but these gains became evident > 3 years post-treatment. At two years post-treatment all measured variables were greater in QVM plots, but we found no significant differences in these mean growth increments (dbh, P=0.15; total height, *P*=0.25; cubic foot volume per stem, *P*=0.06), between treated and control plots (Table 4).

Table 4--Mean diameter (in.), total height (ft.), and volume per stem (cu. ft.) growth increment on control and QVM plots two years post treatment (9 sites).

Treatment	Diameter	Height	Volume
Control	0.79	5.68	3.2
QVM	0.85	6.04	3.4

Due to a variety of circumstances over the past three years which has resulted in the loss of three stands from the study, two year results are from the nine remaining stands. Although not significant, mean growth increment increases on treated plots tended to be greater than those on control plots. Assuming this increment represents a true treatment effect, application of the QVM treatment resulted in a volume increase of 37.68 cubic feet per acre, or \$22.23 of additional revenue per acre. With the two year increase in value, application of the QVM treatment offset between 20 (without cost share) and 40 (with cost share) percent of wildlife habitat improvement costs (herbicide, herbicide application, and prescribed fire). There are currently two programs included in the 2002 Farm Bill that offer cost sharing for QVM; the Conservation Reserve Program (CRP) and the Wildlife Habitat Incentive Program (WHIP). These programs provide up to \$50 per acre in cost share for QVM, but pine stands must meet specific eligibility criteria (Burger et al. 2004). To earn a 6 percent rate of return by year four without cost share assistance, an increase in volume of 219 cubic feet would need to be produced in treated stands over the next two years. Whereas with cost share assistance a 6 percent rate of return could be achieved with an increase in 69 cubic feet of volume over the next two years. As seen in similar studies (Shiver 1994, Oppenheimer et al. 1989, Pienaar et al. 1983) growth response continues to increase with time since treatment. We expect that the increases in growth observed to this point will become more evident by year four post-treatment or later.

Conclusions

The results presented here give two year post-treatment responses of timber growth and avian communities to the QVM treatment, and, although still early for this type of study, are promising. Increases in the relative abundance of several target avian species was encouraging. Woodall (2005) reported that by year four the total abundance, species richness, and total avian conservation value were greater in QVM treated plots than untreated (control) plots. Ongoing monitoring of bird communities on these sites will determine whether patterns of avian abundance observed in commercial pine plantations occur similarly on CRP pine plantations. Pienaar et al. (1983) demonstrated mid-rotation competition control can be successful in producing gains in timber growth, but usually these gains begin appearing ≥ 3 – 4 years post-treatment and increase as time since treatment increases. Given more time to monitor timber growth responses to the QVM treatment, we expect to see similar results.

Literature Cited

Allen, A.W., Y.K. Bernal, and R.J. Moulton. 1996. Pine plantations and wildlife in the southeastern United States: an assessment of impacts and opportunities. USDI, Infor. and Tech. Rep. 3. Washington D. C.

Bacon, C.G., and S.M. Zedaker. 1987. Third-year growth response of loblolly pine to eight levels of competition control. South. J. Appl. For. 11(2):91-95.

Burger, L.W. 2000. Wildlife responses to the Conservation Reserve Program in the Southeast. Pages 55-74 in W.L. Hohman, ed. A comprehensive review of farm bill contributions to wildlife conservation 1985-2000. Tech. Rep., USDA/NRCS/WHMI – 2000.

Burger, W., S. Demarais, S. Edwards, J. Jones, M. Ragsdale, B. Sladek, B. Stricklad, B. Watkins, and B. West. 2004. Wildlife habitat improved by Quality Vegetation Management. Tree Talk 26(8):19-21.

Chen, M., E.J. Hodgkins, and W.J. Watson. 1975. Prescribed burning for improving pine production and wildlife habitat in the hilly coastal plain of Alabama. Alabama Agriculture Experiment Station, Auburn University, Auburn, AL. Bull. 473.

Creighton, J.L., B.R. Zutter, G.R. Glover, and D.H. Gjerstad. 1987. Planted pine growth and survival responses to herbaceous vegetation control, treatment duration, and herbicide application technique. South. J. Appl. For. 11(4):223-227.

Dills, G.G. 1970. Effects of prescribed burning on deer browse. J. Wildl. Manage. 34:540-545.

Edwards, S.L., S. Demarais, B. Watkins, and B.K. Strickland. 2004. White-tailed deer forage production in managed and unmanaged pine stands and summer food plots in Mississippi. Wildl. Soc. Bull. 32(3):739-745.

Fortson, J.C., B.D. Shiver, and L. Shackelford. 1996. Removal of competing vegetation form established loblolly pine plantations increases growth on piedmont and upper coastal plain sites. South. J. Appl. For. 20(4):188-193.

Hood, S.A. 2001. Response of small mammals and herpetile communities to prescribed burning and herbicide application in thinned, mid-rotation loblolly pine plantations in Mississippi. M.Sc. thesis, Mississippi State Univ., Mississippi State, Mississippi. 87 p.

Hunter, W.C., D.A. Buehler, R.A. Canterbury, J.L. Confer, and P.B. Hamel. 2001. Conservation of disturbance-dependent birds in eastern North America. Wildl. Soc. Bull. 29(2):440-455.

Hurst, G.A. 1989. Forestry chemicals and wildlife habitat. For. Farmer 48(4):10-11.

Jones, J., W. Burger, and B. Watkins. 2003. Bird and plant communities in a loblolly pine forest managed with prescribed fire and herbicide. For. Landowner May/June 2003:29-31.
Knowe, S.A., L.R. Nelson, D.H. Gjerstad, B.R. Zutter, G.R. Glover, P.J. Minogue, and J.H. Dukes, Jr. 1985. Four-year growth and development of planted loblolly pine on sites with competition control. South. J. Appl. For. 9(1):11-15.

Merrifield, R.B., and R.R. Foil. 1967. Volume equations for southern pine pulpwood. Hill Farm Facts, For. Pub. No. 7. North Louisiana Hill Farm Experiment Station, Homer, Louisiana.

Nuttle, T., A. Leidolf, and L.W. Burger. 2003. Assessing the conservation value of bird communities with Partners in Flight-based ranks. Auk 120:541-549.

Oppenheimer, M.J., B.D. Shiver, and J.W. Rheney. 1989. Ten-year growth response of mid-rotation slash pine plantations to control of competing vegetation. Can. J. For. Res. 19:329-334.

Piennaar, L.V., J.W. Rheney, and B.D. Shiver. 1983. Response to control of competing vegetation in site-prepared slash pine plantations. South. J. Appl. For. 7(1):38-45.

Quicke, H. 2002. Fourth-year response following operational scale mid-rotation release with Arsenal herbicide applicators concentrate: The 1994 Waverly Hall Study. American Cyanamid For. Res. Rep. 99-02.

Robbins, C.S., D. Bystrak, and P.H. Geissler. 1986. The breeding bird survey: its first fifteen years, 1965-1979. USDI Fish and Wildl. Ser., Res. Pub. 157.

Schultz, R.P. 1997. Loblolly pine: the ecology and culture of loblolly pine (*Pinus taeda*L.). Agric. Handb. 713. USDA For. Ser., South. For. Exp. St., New Orleans, LA.

Shiver, B.D. 1994. Response and economics of mid-rotation competition control in southern pine plantations. Pages 85-92 in Weed Science Education: “the cost of ignorance”. 47th Annual Meeting of the South. Weed Sci. Soc. January 17-19. Dallas, TX.

Thompson, J.L.R. 2002. Response of plant and avian communities to prescribed burning and selective herbicide treatments in thinned, mid-rotation loblolly pine plantations in Mississippi. M.Sc. thesis, Mississippi State Univ., Mississippi State, Mississippi. 162 p.

Timber Mart-South. 2004. Yearly Summary, 4th Quarter 2004, 29(4). Daniel B. Warnell Sch. of For. Resour., Univ. of Georgia.

USDA. 2003a. USDA, Nat. Res. Con. Ser., National Bull. 300-3-3. http://policy.nrcs.usda.gov/scripts/lpsiis.dll/NB/NB_300_3_3.htm, March 31, 2005.

USDA. 2003b. Highlights of expected Conservation Reserve Program (CRP) changes for 2003 and beyond. USDA, Nat. Res. Con. Ser., National Bull. 300-3-4.

http://policy.nrcs.usda.gov/scripts/lpsiis.dll/NB/NB_300_3_4.htm, March 31, 2005.

USDA. 2005. Conservation Reserve Program, Monthly Summary, February 2005. USDA, Farm Ser. Agen.
http://www.fsa.usda.gov/dafp/cepd/stats/Feb2005.pdf, March 31, 2005

Woodall, L.T. 2005. Response of plant and avian communities to prescribed burning and selective herbicide treatments in thinned, mid-rotation loblolly pine plantations in Mississippi. M.Sc. thesis. Mississippi State Univ., Mississippi State, Mississippi. 117 p.

Concurrent Session 5A: Fire Economics II

FTM–West: Fuel Treatment Market Model for U.S. West

Peter J. Ince[1], Andrew Kramp, Henry Spelter, Ken Skog, Dennis Dykstra, USDA Forest Service

Abstract

This paper presents FTM–West, a partial market equilibrium model designed to project future wood market impacts of significantly expanded fuel treatment programs that could remove trees to reduce fire hazard on forestlands in the U.S. West. FTM–West was designed to account for structural complexities in marketing and utilization that arise from unconventional size distributions of trees and logs removed in fuel treatment operations as compared with conventional timber supply in the West. For example, tree size directly influences market value and harvest cost per unit volume of wood, whereas log size influences product yield, production capacity, and processing costs at sawmills and plywood mills. Market scenarios were projected by FTM–West for two hypothetical fuel treatment regimes that yield wood with divergent size class distributions, evaluated at two hypothetical levels of administrative cost or government subsidy. Results suggest that timber markets could economically utilize substantial volumes of wood from hypothetical treatment programs, even without any subsidy. Given an optimistic overall market outlook, model results indicate potential for expansion of total wood harvest in the West if fuel treatment programs will permit significantly expanded wood supply from forest thinning, in which case fuel treatment programs could partially displace timber harvest from conventional supply sources (mainly state and private forestlands), reduce timber prices, and offset regional timber revenues, while expanding regional forest product output.

Acknowledgments

This study was funded in part by the Joint Fire Science Program (JFSP), a partnership of six federal agencies: USDA Forest Service, Bureau of Indian Affairs, Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, and U.S. Geological Survey. Additional in-kind contributions were provided by researchers at the USDA Forest Products Laboratory and Forest Service Pacific Northwest Research Station. The study was part of a larger JFSP-funded project, identified as JFSP project 01-1-2-09, “A national study of the economic impacts of biomass removals to mitigate wildfire damages on federal, state, and private lands,” coordinated by Jeffrey Prestemon and Karen Lee Abt (Forest Service Southern Research Station). The authors sincerely appreciate the consultation provided by the project coordinators, as well as consultation on the PELPS modeling system from Patti Lebow of the Forest Products Laboratory, data input from Matt Alderman of the Forest Products Laboratory, and consultation or input from other members of the JFSP project, including Roger Fight and Jamie Barbour of the Pacific Northwest Research Station and Bob Rummer and Robert Huggett, Jr., of the Southern Research Station.

---

[1] Research Forester, USDA Forest Service, Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI, 53726-2398. pince@fs.fed.us. (608) 231-9364 (v); (608) 231-9592 (fax)

Introduction

The Healthy Forests Restoration Act of 2003 (HFRA) and other administrative rules encourage expansion of hazardous fuel reduction projects on public forestlands in the United States. Most of the area treated in hazardous fuel reduction projects in recent years has involved prescribed burning and mechanical thinning without wood removal. However, some mechanical thinning projects have involved wood removal, and many conventional timber harvest projects on public lands also serve fuel reduction objectives.[2] In general, the hazardous fuel reduction program of the future might involve expanded wood removals. Thus, the purpose of this study was to develop an economic model that could be used to assess market impacts of alternative fuel reduction programs involving forest thinning in the U.S. West. Model development was guided by awareness that forest thinning programs could very likely involve removal of trees with size-class distributions different from the size-class distribution of trees from conventional timber harvests in the West. It was understood that market impacts will be influenced by divergent size-class distributions, because the economics of wood harvesting, utilization, and production processes are all known to depend on tree and log size-class distributions.

Methodology

The "fuel treatment market" model for the U.S. West (FTM–West) employs the Price Endogenous Linear Programming System (PELPS). PELPS is a general economic modeling system developed originally at University of Wisconsin (Gilless and Buongiorno 1985, Calmels et al. 1990, Zhang et al. 1993) and more recently modified for applications at the Forest Products Laboratory (Lebow et al. 2003). PELPS-based models employ Nobel laureate Paul Samuelson's spatial equilibrium modeling approach, with periodic (e.g., annual) market equilibrium solutions obtained via economic optimization. Solutions are derived via maximization of consumer and producer surplus, subject to temporal production capacity constraints, transportation and production costs, and price-responsive raw material supply curves and product demand curves, all of which can be programmed realistically to shift over time and respond to endogenous shifts in market conditions. FTM–West employs the FPL version of PELPS (called FPL–PELPS); Lebow et al. (2003) and earlier PELPS publications provide further mathematical details about the modeling system. PELPS has been used fairly widely for partial market equilibrium models of timber and forest products for many years (for example, Buongiorno et al. 2003, Zhang et al. 1996, ITTO 1993).

Many structural aspects of wood product markets are commonly represented in forest sector market models, including, for example, a regional market structure with regional product demand curves, regional raw material supply curves, interregional transportation costs, regional production capacities, and manufacturing costs. Those general structural features were also included in FTM–West. However, added structural complexities arise with marketing and utilization of wood with divergent size-class distributions from fuel treatment programs, and those complexities required unique structural features to be designed and incorporated into FTM–West (as discussed in the next section).

---

[2] The Stewardship Contracting program on National Forests and BLM lands, for example, has involved removal of trees in thinning projects that seek to reduce hazardous fuels and improve forest health.

Among general structural features, FTM–West included demands for more than a dozen forest product commodities encompassing the full spectrum of products produced from softwood timber in the U.S. West, several demand regions, eight production or supply regions, and both conventional softwood timber supply and wood supply from thinning programs (assumed to be primarily softwoods). Table 1 summarizes the regional and commodity structure. The model includes only demands for forest products produced from softwood timber in the U.S. West, just a partial representation of total U.S. and global demands for forest products. Fairly simple demand curves were specified in the model based on an assumption that demands for all products are inelastic (price elasticity of demand ranged from –0.3 to –0.8 among the various products). Aggregate demand quantities for each product were equated to product output data for the U.S. West in the base year (1997) and proportioned to each of the three product demand regions using estimates of regional shipments from the West. FTM–West was programmed to solve annual market equilibria over a 24-year period, 1997 to 2020, which permits testing of solutions against overlapping historical data. Demand curves were shifted each year based on historical shifts in production in the U.S. West (1997 to 2004), and the model was also programmed with a set of assumed future growth rates in regional demands (2005 to 2020) for each forest product commodity.

Similarly, simple supply curves were used to model conventional softwood timber supply in each of the eight supply regions, while exogenous estimates of wood supply from treatment programs (upper bounds on harvest quantity and harvest costs) were introduced as policy or program variables. Conventional timber supply in the U.S. West is currently obtained primarily from state and private forestlands, subjected mainly to even-aged timber management. Thus, inelastic supply curves were used for conventional timber supply (with an estimated price elasticity of 0.7)[3]. Conventional timber supply curves were programmed to shift over time in proportion to net growth in softwood timber inventory volumes on state and private timberland within each supply region. Annual net growth in timber inventories were computed each year by deducting from standing timber inventories the harvest volumes from the preceding year and adding timber volume growth (based on recent growth rates in each region). Thus, FTM–West incorporated fairly standard techniques to model conventional timber supply (that is, inelastic supply curves shifted over time in proportion to projected net growth in timber inventories).

Table 1. Regional and commodity structure of FTM–West model

Supply/production regions	*Demand regions*	*Demand commodities*
Coast PNW (OR, WA)	U.S. West	Softwood lumber & boards
Eastern Washington	U.S. East	Softwood plywood
Eastern Oregon	Export market	Poles & posts
California		Paper (five grades)
Idaho	*Supply commodities*	Paperboard (three grades)
Montana	"Pines"	Market pulp
Wyoming–South Dakota	"Non-Pines"	Hardboard
Four-Corners (UT, CO, AZ, NM)	(trees, logs, chips)	Fuelwood

[3] Supply and demand elasticities were calibrated based on goodness-of-fit comparisons between model equilibrium projections and actual historical price and quantity data.

Separate supply curves were included in the model for "pines" and "non-pines," with base-level conventional timber supply quantities determined by Forest Service estimates of 1996 timber harvests within each supply region (Johnson 2001). The distinction between "pines" (ponderosa and Jeffrey pines) and "non-pines" (other softwood species) was programmed into the model because some important lumber products in the West (boards and specialty products) are made almost exclusively or predominantly using "pines," and thus "pines" tend to have higher market value than "non-pines." By including separate supply curves for "pines" and "non-pines" and realistic estimates of input requirements by species group among various products, FTM–West modeled more realistically the market differential between these two principal species groups.

The Fuel Treatment Evaluator program (FTE 3.0) was used to derive estimates of potential wood harvest from future treatment programs (2005 to 2020) for both "pines" and "non-pines." FTE 3.0 is a separate computer program[4] that uses Forest Service forest inventory and assessment (FIA) data to derive detailed regional estimates of harvestable wood on public lands in the West under various treatment regimes, given specified assumptions about forest thinning objectives and constraints, such as fire hazard reduction goals and minimum volumes per acre for thinning (McRoberts and Miles 2005, Skog et al. 2005). FTE provided estimates of upper bounds (maximum potential harvest volumes) and size class distributions of harvestable wood under two alternative treatment regimes, which included SDI (stand density index) thinning and TFB (thinning from below).[5] SDI refers to a treatment regime that removes trees across the spectrum of age or size classes, leaving uneven-aged residual stands (with reduced stand-density index), whereas TFB refers to a regime that targets removal of smaller trees or younger age classes of trees only and leaves largely even-aged (older age class) residual stands. Harvesting costs for wood removed by thinning were estimated also by FTE 3.0, using the calculation routine from "My Fuel Treatment Planner" (Biesecker and Fight 2005).

In addition to supply and demand curves, the FTM–West model incorporated estimates of manufacturing capacities for all the various products in each of the eight production regions, manufacturing cost data, and also transportation cost data (for wood raw material and product shipments). A feature of PELPS is that production capacities can shift over time in response to economic conditions, and in FTM–West we used a representation of Tobin's q model to project regional capacity change as a function of the ratio of shadow price (or value) of production capacity to cost of new capacity (Lebow et al. 2003).

Complexities in wood utilization modeled in FTM–West

Beyond the general aspects of model structure, some unique structural elements were also incorporated into FTM–West specifically to account for known complexities associated with marketing and utilization of wood from fuel treatments. The need to model those complexities stems from awareness that the size class distribution of harvest (that is, the distribution of wood volumes by tree diameter class) will likely be different for wood removed in fuel treatments than for conventional timber supply. Also, it is fairly well known that timber market value and harvest

---

[4] An Internet link to FTE 3.0 is at the following website: www.ncrs2.fs.fed.us/4801/fiadb/. FTE 3.0 was accessed in September of 2005 to obtain data for this report.
[5] The SDI thinning regime was composed of FTE 3.0 uneven-aged treatments 2A and 4A, and the TFB regime was composed of FTE 3.0 treatments 3A and 4A (see Skog et al. (2005) and preceding website).

costs per unit volume are highly dependent on tree size class or diameter, whereas mill production capacity, processing costs, and product yields also vary with log diameter, particularly at lumber and plywood mills.

In recognition of the variable size classes of trees harvested, both the conventional timber harvest and the exogenously specified wood harvest from fuel treatments were modeled by 2-in. (5-cm) diameter classes, ranging from trees <5 in. dbh (diameter at breast height) to trees >15 in. dbh. Thus all wood supplies for both "pines" and "non-pines" were disaggregated into seven different tree size classes, each of which can assume a unique market value in the model. Furthermore, each different tree size class yields different proportions of logs (by 2-in. log size class) along with variable quantities of wood chip raw materials. Estimates of actual log and chip volume yields for each tree size class were derived for each of the eight supply regions based on recovery data from regional utilization studies conducted at the Forest Service Pacific Northwest Experiment Station (compiled from mill studies by Dennis Dykstra, PNW Station).

In addition to modeling wood supply by tree diameter class, with data on wood chip and log recovery by log size class, FTM–West was programmed with data on harvest costs, product recovery, and production costs unique to each size class of material. FTE 3.0 was used to estimate harvest costs for wood from fuel treatments, and timber harvest costs for conventional timber supply were estimated by tree diameter class using a different timber harvest cost model (Keegan et al. 2002). Production costs and product recovery potential were based on known relationships between product yields and production costs across the range of log size classes. In sawmills for example, wood input, production costs, and mill capacity all vary with log size, as product yield and throughput all increase with log size. Realistically, wood input requirements, production costs, and production capacity all vary by log size class in FTM–West for products where efficiencies vary by log size class (lumber, boards, and plywood). In other products such as pulp-based paper products, product yields, costs, and capacity were not programmed to vary by tree or log size class.

Thus, FTM–West incorporated unique structural features to reflect well-known complexities in marketing and utilization of wood, including disaggregating wood supplies into a range of tree size classes, further disaggregating recoverable log sizes and chip recovery by tree size class, and modeling harvest costs, product yields, production costs, and production capacities as variables, by tree or log size class. Those realistic features of the model enable projection of the market impacts of increased wood removal even in cases where wood supplies from treatment programs are expected to have substantially different size-class distributions than conventional timber supply. Figure 1 illustrates general structural aspects of the FTM–West model.

Data

A comprehensive description of all supply, demand, capacity, and cost data in FTM–West is beyond the scope of this brief report, but input data is described here for wood supply from the alternative fuel treatment regimes, SDI and TFB. Raw input data from the FTE 3.0 program included regional estimates of total harvestable wood (and corresponding potential treatment acreages). Those estimates totaled 23.2 billion cubic feet and 10.9 million acres in the West for SDI; 9.9 billion cubic feet and 5.6 million acres for TFB. FTE derived those estimates from

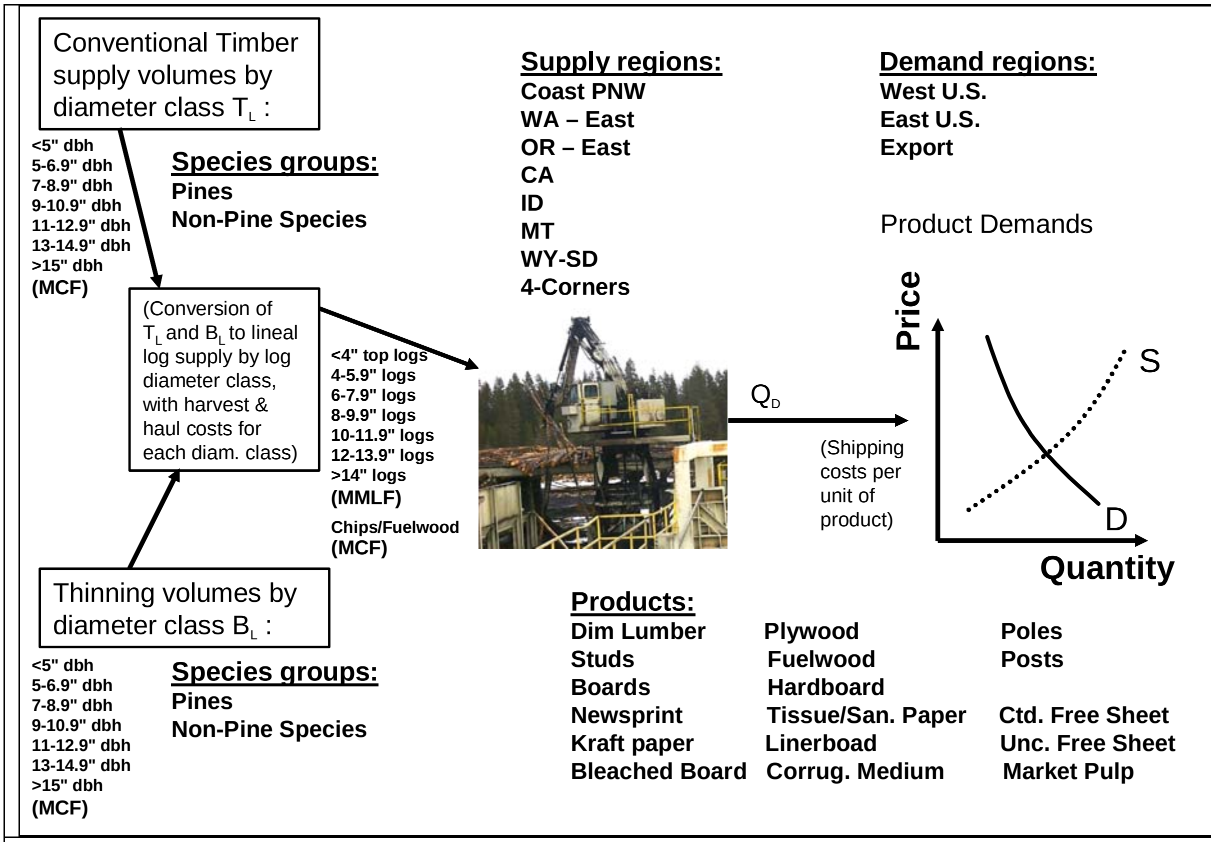


Figure 1. Illustration of FTM–West model structure.

Forest Service (FIA) timber inventory data using a different set of criteria to choose the acres for treatments according to the two treatment regimes. Thus, the SDI and TFB thinning regimes were applied to the same public land base (in the West), but the acres estimated to be treatable and harvestable wood volumes were different under the two regimes because of different treatment criteria (for more details on the fuel treatment criteria, see Skog et al. (2005)).

Some additional basic assumptions were then applied to extrapolate the FTE wood supply and harvest cost data over the projection period from 2005 to 2020. The first assumption was that future treatment programs would require removal of all tree size classes targeted for thinning and not allow “high grading” of the most valuable trees. Under that realistic management assumption, it was reasonable to adopt a simplifying assumption that the size class distribution of trees thinned each year and average harvest cost would remain roughly constant in each region. An additional assumption was that future thinning programs would expand along the path of a reasonable growth function, and therefore a simple log-normal growth function was used to distribute harvestable wood supply over time. Figure 2 shows aggregate projected wood quantities (upper bounds on supply from thinning) available annually in the entire West (total of all eight supply regions) under the SDI and TFB treatment regimes, based on the log-normal growth distribution over time. Figure 3 shows the corresponding acreage of forest that would be thinned annually if all harvestable wood quantities were removed each year.

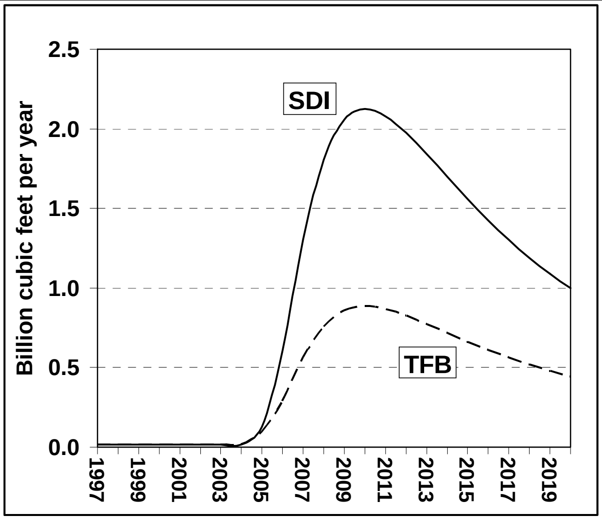


Figure 2. Wood quantities harvestable annually under SDI and TFB treatment regimes.

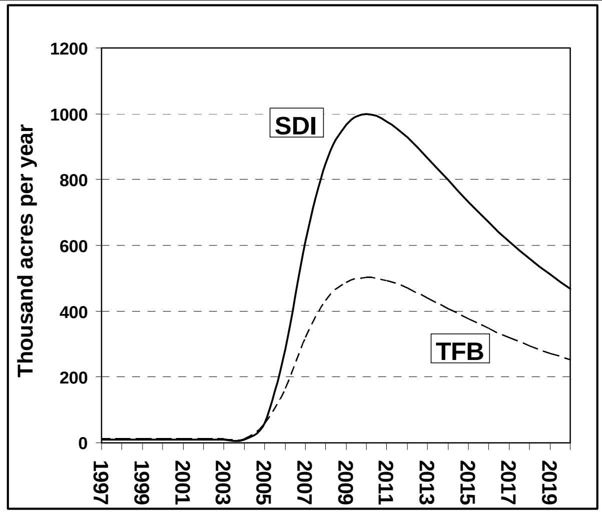


Figure 3. Acreage potentially treatable each year under SDI and TFB treatment regimes.

It can be noted also that total harvestable wood volumes and acreages potentially treatable were much higher under the SDI thinning regime than under TFB (Figures 2 and 3). This is partly because a higher proportion of larger-diameter trees are removed typically under an SDI (uneven-aged) thinning regime and also a larger acreage would be treated under SDI than under the TFB regime. In fact, compared with the estimated distribution of volume by diameter for conventional timber harvest in the West (in 1996), the SDI thinning regime would involve removal of trees with higher average diameter than conventional timber harvests, whereas the TFB regime would involve removal of trees with lower average tree diameter than in conventional timber harvests.

Figure 4 shows for comparison the estimated volume distributions in percentages by tree diameter class for conventional timber harvest in the West (1996) and for wood removals from the TFB and SDI treatment regimes. It can be noted that the estimated distribution of volume by size class for conventional timber harvest (in 1996) was fairly broad and included substantial shares of volume in smaller size classes. Generally speaking, the era of harvesting primarily large old-growth timber in the U.S. West had come to an end well before 1996, resulting in a more normal distribution of harvest volume by tree diameter class (less skewed toward larger size classes than was historically the case). For both treatment regimes (TFB and SDI), a larger proportion of removable volume was estimated to be in the smallest size classes (<5 in. and 5–6.9 in. dbh) than for conventional timber harvest. Thus, both treatment regimes present a challenge of utilizing a higher proportion of small-diameter trees than used conventionally in the West; however the SDI thinning regime (aimed at producing uneven-aged residual stands) would also provide a much higher than conventional share of volume in the largest size class (>15 in. dbh), based on the estimates from FTE 3.0.

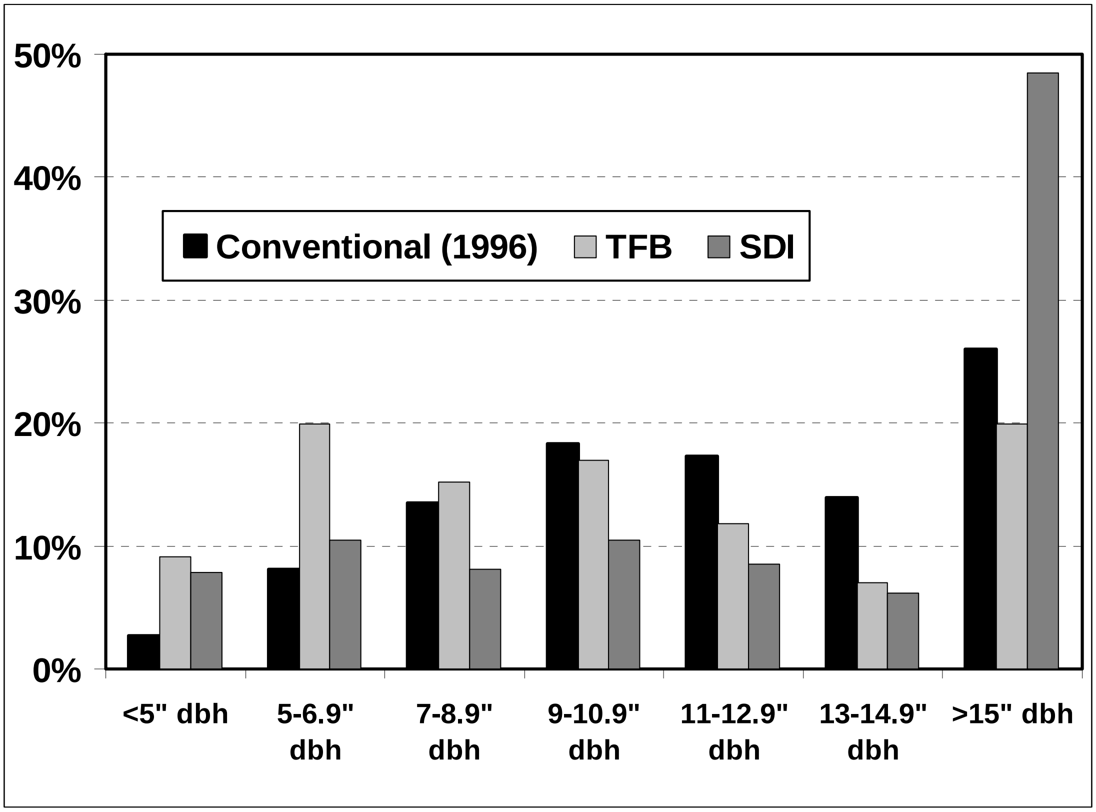


Figure 4. Percentage distribution of wood removal volumes by tree diameter class for conventional timber harvest in the U.S. West (1996) and for wood removed by thinning from TFB and SDI fuel treatment regimes.

Analysis

FTM–West was used to project market impacts from 2005 to 2020 for both the TFB and SDI treatment regimes, with and without hypothetical harvest cost subsidies, as compared to a "base" scenario in which no additional wood was supplied from treatment programs over the projection period. Thus, five different model runs or market scenarios were involved in the analysis, as summarized in Table 2. In the scenarios where no cost subsidy was applied, it was assumed hypothetically that treatment operations would be assessed an administrative fee of $500 per acre (which is in the vicinity of average administrative cost fees charged to conventional timber harvest operations on public lands in the West). In the scenarios with cost subsidy, it was assumed hypothetically that there would be a government subsidy of $200 per thousand cubic feet (MCF) of wood removed, and the administrative costs would be waived. No other fees or subsidies were associated with wood removal under the hypothetical treatment program scenarios.

The administrative cost assumption is reflective of mid-range costs for conventional timber sales on public lands in the West, but it should be emphasized that all assumptions regarding administrative fees and subsidy levels among these scenarios are purely hypothetical and do not necessarily reflect actual costs or potential subsidy levels that may be associated with future fuel

Table 2. Treatment program scenarios analyzed in this study using FTM–West model			
Scenario	Expanded thinning	Cost subsidy	Admin. costs
1. Base	No	N.A.	N.A.
2. TFB—no subsidy	Yes	No	$500/acre
3. TFB—subsidy	Yes	$200/MCF	No
4. SDI—no subsidy	Yes	No	$500/acre
5. SDI—subsidy	Yes	$200/MCF	No

treatment programs.[6] The hypothetical cost and subsidy values were included only to analyze how the market could respond to hypothetical base-level program costs or subsidy levels. At present, subsidies are not generally available for large-scale wood removal programs, although public agencies have subsidized some fuel treatment operations in recent years, mainly prescribed burning and mechanical thinning without wood removal. The hypothetical $500 per acre administrative cost is within the vicinity of typical administrative costs assessed to conventional timber harvest operations on public lands in the West, but the actual extent to which administrative costs might be assessed in future fuel treatment operations remains speculative, and the cost assumption is therefore hypothetical.

Results

A leading result of the analysis was that the market could economically utilize two-thirds or more (but not all) of the harvestable wood volumes from either the SDI or TFB regimes, and (as expected) wood removals increase with higher subsidy levels. Projected wood removals from thinning regimes in the West are illustrated in Figure 5, which shows equilibrium projections of annual wood removals reaching 0.5 to 1.5 billion cubic feet per year, depending on treatment regime and subsidy levels. For the SDI (uneven aged) thinning regime, 67% of total harvestable (upper bound) wood supply was projected to be actually harvested and utilized by the market when charged an administrative fee of $500 per acre. Similarly, under the TFB regime 68% of harvestable wood volume was projected to be harvested and utilized by the market with an administrative fee of $500 per acre. Substantially higher shares of harvestable wood volumes were projected to be harvested and utilized by the market if the $500 per acre administrative cost is replaced by a harvest subsidy of $200 per MCF (84% for SDI and 91% for TFB).

Equilibrium levels of wood removals correspond to sizable projected acreages of public forestland treated in the West. Figure 6 illustrates projected acreage treated annually via thinning and wood removal under the SDI and TFB thinning scenarios, with and without hypothetical subsidies. The acreage treated increases with subsidy, but substantial acreages are also projected to be treated without subsidy (at administrative fees of $500 per acre). Over the 16-year projection period 5.8 million acres are projected to be treated under the SDI regime and 3.4 million acres under the TFB regime without any subsidies, while 8.4 million acres are projected

[6]Future thinning programs may for example include additional stumpage fees for wood removed.

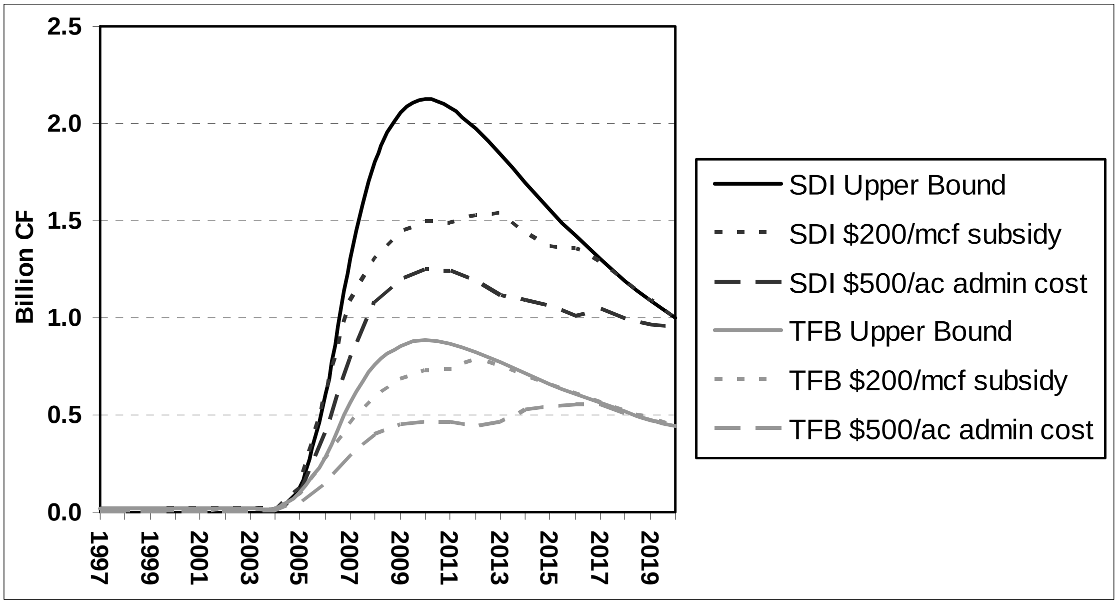


Figure 5. Upper bounds on harvestable wood volumes from SDI and TFB regimes and equilibrium wood harvests under alternative subsidy or administrative cost scenarios.

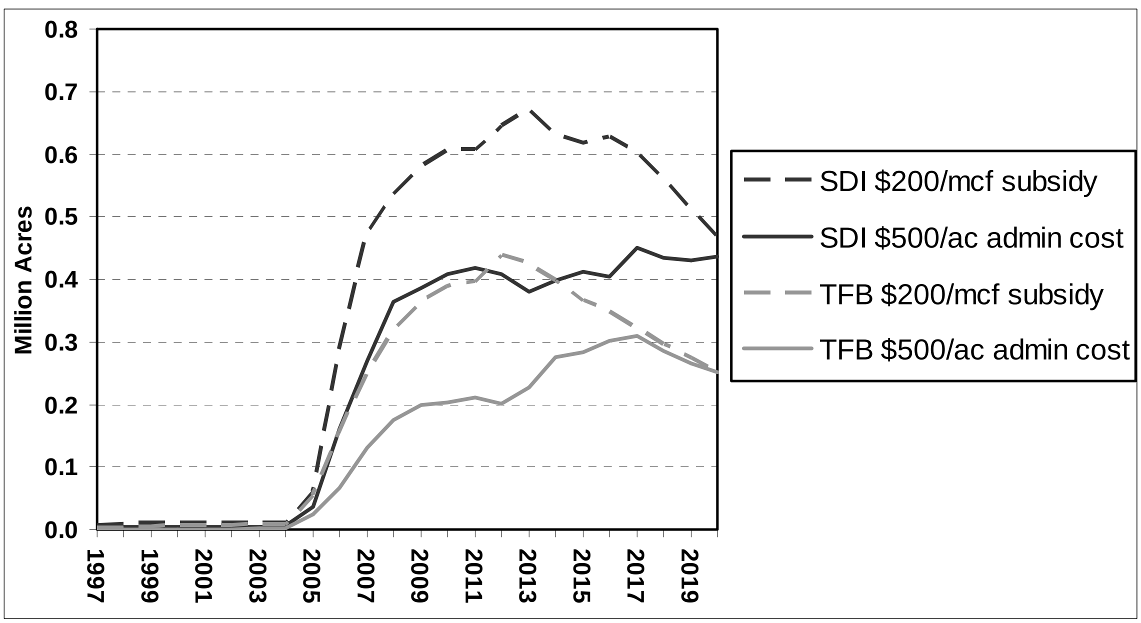


Figure 6. Projected acreage treated annually by SDI and TFB treatment regimes under alternative subsidy or administrative cost scenarios.

to be treated under the SDI regime and 5.0 million acres under the TFB regime with a subsidy of $200 per MCF of wood removals.

An important set of additional results from the economic analysis were the projections of broader economic impacts of expanded fuel treatment thinning programs on timber markets in the U.S. West. In particular, the analysis projected impacts on regional timber prices and overall timber harvest (including timber harvest from conventional supply sources). Combining projected impacts on regional timber prices and regional harvest of timber, the results provided an indication of projected impacts on timber revenues in the region. Because most timber supply in the West is currently obtained from state and private forestlands, the projected impact on timber revenues would be primarily an impact on state and private timber revenues.

Increased wood supplies from the hypothetical fuel treatment programs were projected to substantially offset projected increases in timber stumpage prices in the U.S West. The base scenario, with no expansion of wood supply from fuel treatment programs (and limited expansion of timber supply from conventional sources in the region) resulted in a steadily increasing real price trend for softwood timber stumpage over the projection period, more or less in line with the historical price trend of recent years. Figure 7 illustrates the projected average real price trend for softwood timber stumpage in the West (weighted by volume across all timber size classes) for the base scenario (with no expansion of supply from fuel treatments) and also projected timber price trends under the hypothetical TFB and SDI treatment regimes, both with and without subsidies. In contrast to the steadily increasing real price trend of the base scenario, the projected regional timber price trends under the hypothetical treatment programs were substantially lower. In all scenarios timber prices were projected to eventually increase in the West (beyond 2010), but the near-term impacts of the expanded treatment programs were to stabilize or reduce projected timber prices for a number of years (Figure 7).

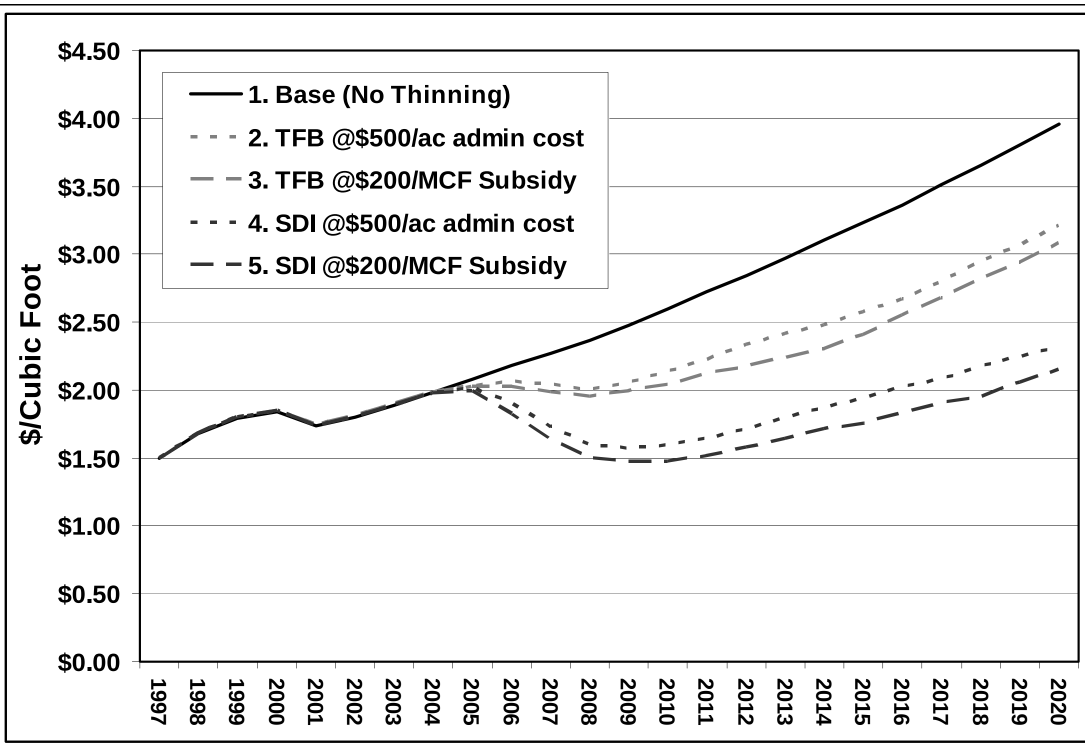


Figure 7. Projected average real timber stumpage price trends in U.S. West for base scenario (no expansion of fuel treatment thinning) and with hypothetical TFB and SDI treatment scenarios (at two different levels of administrative cost or subsidy).

Results indicated that total wood harvest in the U.S. West could expand with thinning from fuel treatment programs, partly displacing harvest of timber from conventional supply sources (mainly state and private forestlands) and resulting in lower average timber stumpage prices. The SDI treatment regime has a larger impact than the TFB regime because larger wood volumes are removed under the SDI regime. Figure 8 illustrates projected impacts of the SDI treatment programs on annual wood harvests relative to the base scenario. Total wood harvest increases with fuel treatments, but there is a displacement of timber harvest from conventional supply sources. Smaller but similar impacts were observed in the results for the TFB regimes. Wood removals from the hypothetical fuel treatment programs were projected to reach peak levels of 15% to 39% of total annual wood harvest in the West during the next decade, depending on scenario.

Reduced timber prices (Figure 7) and displacement of harvests from conventional timber supply sources in the West (Figure 8) combine to offset regional timber revenues for conventional timber suppliers (mostly state and private forests in the West). Relative to the base scenario, the TFB treatment with no subsidy was projected to offset timber revenues for conventional suppliers of timber by 37 billion dollars cumulatively over the period from 2005 to 2020, while the subsidized TFB treatment offset conventional timber revenues cumulatively by 49 billion dollars. Similarly, the SDI treatment without subsidy was projected to offset conventional timber revenues cumulatively by around 78 billion dollars, whereas the subsidized SDI treatment was projected to offset conventional timber revenues cumulatively by upwards of 90 billion dollars from 2005 to 2020.

However, in addition to offsetting effects on regional timber revenues, FTM–West also projected

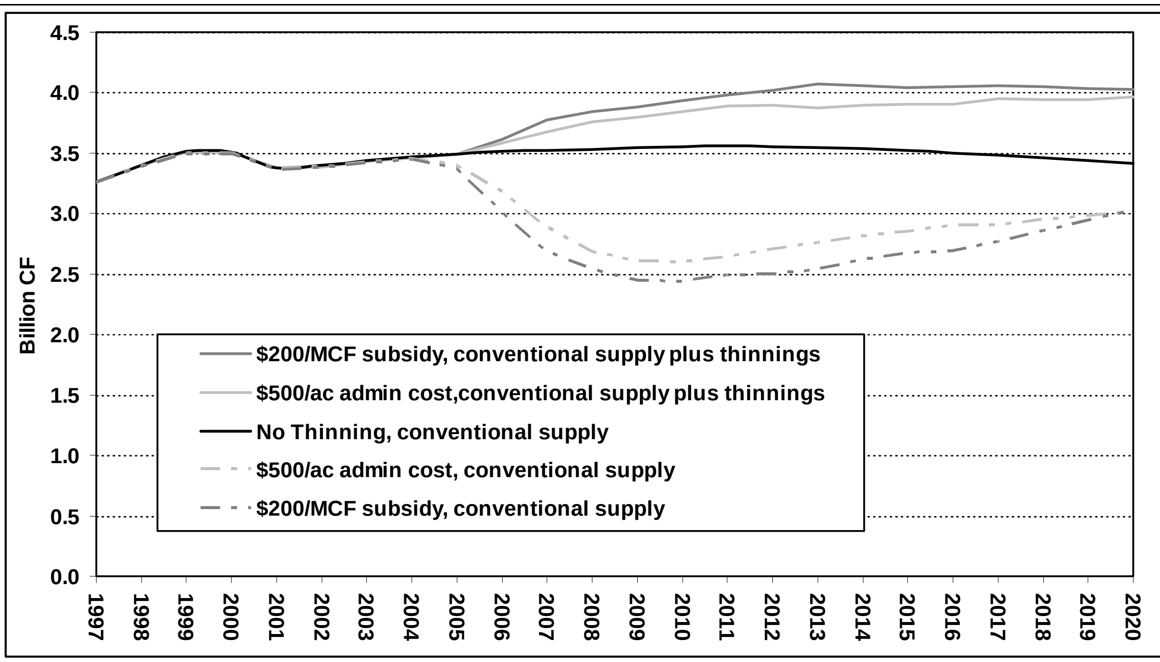


Figure 8.— Projected timber harvest in U.S. West from conventional supply sources with no expansion of thinning, and also total harvest and harvest from conventional supply sources with SDI treatment thinning program (at two levels of admin. cost or subsidy)

a positive effect of the treatment programs—expanded output of forest products in the West and lowered cost of forest product production in the region (with lower timber costs). The full extent of consumer welfare implications of that effect are beyond the scope of this report and can be approached only in a partial sense because FTM–West is a partial market equilibrium model (and does not include economic sectors that could benefit from lower costs or increased output of forest products, such as the housing sector). Nevertheless, the model does suggest that losses of timber revenues to conventional suppliers of timber will be at least partly mitigated by benefits that would accrue as a surplus to consumers of timber and wood products as a result of increased product output with lower timber costs. A separate study by our colleagues in the JFSP project (Abt and Prestemon 2006) led to development of another economic model of interrelated timber markets in the U.S. West, and their findings concluded that revenue losses to U.S. private timber producers would exceed gains for timber consumers (mills).

Summary and Discussion

This paper provides a brief overview of FTM–West and shows some of the model's projections for hypothetical fuel treatment programs involving forest thinning on public lands in the U.S. West. The scenarios allow wood from treatment programs to enter the market for timber and wood products in the U.S. West. FTM–West was designed to project the market equilibrium in wood utilization, balancing supply and demand for wood from thinning programs against conventional timber supply and demand in the region. Results show that a substantial share (two-thirds or more) of wood available from treatment programs could be utilized by the market, partly displacing conventional timber harvest and offsetting projected timber stumpage prices in the region. In the treatment scenarios, two alternative levels of administrative cost or subsidy were imposed, either an administrative fee of $500 for every acre thinned or a subsidy of $200 per thousand cubic feet (MCF) of wood removed (with no administrative fee). No other fees or subsidies for wood removal were assumed for the hypothetical thinning programs.[7]

FTM–West was designed to model economic complexities that can arise in utilization of wood from treatments that produce unconventional size-class distributions, such as higher proportions of smaller diameter timber (which increases harvest costs, reduces product yield and throughput capacity at sawmills, and increases production costs). Those structural complexities were embedded in the scenarios analyzed in this study, yet the model still projected that the market could economically utilize substantial volumes of wood from the treatment programs in the U.S. West. Furthermore, large volumes of wood projected to enter the market from expanded treatments resulted in significant projected timber revenue impacts within the region. The cumulative timber revenue impacts were an order of magnitude larger than the cumulative amounts of subsidies or administrative fees associated with the hypothetical fuel treatment programs. Table 3 summarizes the cumulative thinning accomplishments and regional timber revenue impacts (from 2005 to 2020) of the treatment program scenarios examined in this study.

[7] The fact that substantial volumes of wood from thinning were projected to be removed even under the higher administrative fee assumption suggests that yet higher administrative fees or added stumpage fees could be charged, but that would of course reduce the quantity of material absorbed by the market.

Table 3. Cumulative thinning results, costs, and regional timber revenues (2005–2020) for base scenario and hypothetical treatment programs analyzed using FTM–West model					
	Treatment program (public lands)				
Scenario	Acres thinned (million acres)	Wood removed (million cubic feet)	Subsidies ($billion, cumulative)	Admin. fees ($billion, cumulative)	Regional timber revenue[8] ($billion, cumulative)
1. Base	(0)	(0)	(0)	(0)	164.55
2. TFB—no subsidy	3.390	6,752	(0)	1.69	127.50
3. TFB—subsidy	4.982	9,085	(1.82)	(0)	115.62
4. SDI—no subsidy	5.758	15,458	(0)	2.88	87.03
5. SDI—subsidy	8.426	19,350	(3.87)	(0)	74.87

Conclusions and Caveats

FTM–West provides a tool for forest economists to model market impacts of expanded fuel treatment thinning programs in the U.S. West, taking into account the structural complexities of tree and log size in relation to marketability and utilization of wood from thinning regimes. Initial analysis concludes that markets could economically utilize large volumes of wood from expanded fuel treatments despite divergent size-class distributions, expanding overall wood harvest in the West. Large-scale expansion could, however, have broader welfare implications via market impacts on price and harvest from conventional timber supply sources. Hypothetical thinning programs were projected to offset the increasing timber price trend in the West, displace timber harvest from conventional timber supply sources (mainly state and private timberlands), and thus offset timber revenues for conventional suppliers of timber in the region. Cumulative timber revenue impacts were projected to be an order of magnitude larger than the administrative costs or subsidies associated with the expanded fuel treatments.

This paper provides what some might view as a relatively optimistic assessment of the economic viability of fuel treatments on public lands, an outlook that appears at odds with current experience. For example, according to fuel treatment data reported by federal agencies, the number of acres that have been treated by mechanical thinning with biomass removal has increased in recent years, but that acreage is still dwarfed by the acreage projected to be treated via thinning in this study. In the past year, fuel treatments on public lands encompassed over 4 million acres nationwide, but well over 90% of the fuel treatment acreage on public lands involved only prescribed burning or mechanical treatments without biomass removal, and thus it remains speculative whether future fuel treatment programs will permit significantly expanded wood supply from forest thinning. However, acreages projected to be treated via TFB and SDI thinning regimes (Figure 6, Table 3) are at most only about 25% to 50% of the acres identified

[8] Timber revenues in Table 3 refer to projected timber stumpage sale revenues (2005–2020) for conventional timber supply in the West (which is primarily from state and private timberlands in the region).

by FTE as being at high risk of catastrophic fire in the U.S. West. In other words, as optimistic as the results may seem, they suggest that treatment by TFB or SDI thinning regimes would not be economically viable on 50% to 75% of high-risk acreage on public lands in the U.S. West.

Another reason for the relatively optimistic assessment of fuel treatment viability was that the results presented here were based on a set of assumptions that did not place wood from fuel treatments at a big disadvantage in the market relative to conventional timber supply, and that helped to boost demand for wood from fuel treatments. Those assumptions included optimistic forest product demand growth, modest differences in harvest cost estimates for conventional timber supply and wood removals from fuel treatments, and volume distributions by size class that did not cause wood supplied from fuel treatments to be at a big disadvantage in utilization compared with conventional timber supply. Reasonable variation in any of these key assumptions could of course result in a different assessment of fuel treatment program viability.

All scenarios presented in this study assumed, for example, the same level of fairly robust forest product demand growth. The robust demand growth outlook contributed to projected timber price increases in the base scenario. A less robust demand outlook will of course result in lower projected timber prices for all scenarios and will tend to diminish the viability and expansion of fuel treatments. Harvest cost estimates for the model were obtained from two different sources, including FTE 3.0, which provided harvest costs for wood removed in fuel treatments, and a different model that provided harvest costs for conventional timber supply (Keegan et al. 2002). Discrepancies in harvest costs between those sources were not very large, but certainly larger variation in assumptions about harvest costs, administrative costs, or subsidies could affect relative competitiveness of wood supply from fuel treatments versus conventional timber supply sources. In addition, the projected distribution of harvest volumes by tree diameter from the fuel treatment regimes were similar enough to the distribution of conventional timber harvest in the West (as shown in Figure 4) that the model allowed substantial volumes of material from the fuel treatment regimes to be assimilated by the market (and to partly displace conventional timber supply). If future fuel treatment regimes were to offer a really different volume distribution (for example, a much higher proportion of smaller timber in comparison to conventional timber supply), then the economic viability and projected expansion of fuel treatments would likely diminish; however, generally speaking, the wood industry in the U.S. West has been adapting to increased use of smaller diameter timber for years.

In summary, the conclusions and results should be viewed in the context of a number of appropriate caveats about basic assumptions used in the FTM–West model. However, those caveats and assumptions also serve as a reminder that FTM–West is a tool that can be used to explore a number of other alternative outcomes and issues related to fuel treatment programs for the future. With tools such as FTM–West, it is possible to explore the likely economic viability and market impacts of alternative treatment regimes, with various assumptions about rates of forest product demand growth, harvest costs, and administrative costs or subsidies for fuel treatments, variation in size class distributions of wood removed in fuel treatments, and variation in other relevant parameters.

References

Abt, K.L., and J.P. Prestemon. 2006. Timber markets and fuel treatments in the western U.S. Natural Resource Modeling 19(1).

Biesecker, R.L., and R.D. Fight. 2005. My fuel treatment planner: a users guide. Gen. Tech. Rep. PNW-GTR-XX. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. (Draft manuscript)

Buongiorno, J., S. Zhu, D. Zhang, J. Turner, and D. Tomberlin. 2003. The global forest products model: structure, estimation and applications. Academic Press. 300 p.

Calmels, P., J. Buongiorno, and D. Zhang. 1990. PELPS II: A microcomputer price-endogenous linear programming system for economic modeling. Research Report R3477. College of Agricultural and Life Sciences, Univ. of Wisconsin–Madison. 40 p.

Gilless, J.K., and J. Buongiorno. 1985. PELPS: Price-endogenous linear programming system for economic modeling. Research Report R3329. College of Agricultural and Life Sciences, Univ. of Wisconsin–Madison. 34 p.

ITTO. 1993. Analysis of macroeconomic trends in the supply and demand of sustainably produced tropical timber from the Asia-Pacific region, phase I. International Tropical Timber Organization: Yokohama, Japan.

Johnson, T.G. (ed.). 2001. United States timber industry—An assessment of timber product output and use, 1996. Gen. Tech. Rep. SRS-GTR-45. Asheville, NC: USDA Forest Service, Southern Research Station. 145 p.

Keegan, C.E., M.J. Niccolucci, C.E. Fiedler, J.G. Jones, and R.W. Regel. 2002. Harvest cost collection approaches and associated equations for restoration treatments on National Forests. Forest Products Journal 52(7/8).

Lebow, P.K., H. Spelter, and P.J. Ince. 2003. FPL-PELPS, A price endogenous linear programming system for economic modeling, supplement to PELPS III, Version 1.1. Res. Pap. FPL-RP-614. Madison, WI: USDA Forest Service, Forest Products Laboratory. 32 p. *www.fpl.fs.fed.us/documnts/fplrp/fplrp614.pdf*

McRoberts, R.E., and P.D. Miles. 2005. Computer-based application tools using forest inventory data from the United States of America. Forest Biometry, Modeling and Information Sci. 1:11-18.

Skog, K., J. Barbour, K. Abt, T. Bilek, F. Burch, R. Fight, B. Huggett, P. Miles, E. Reinhardt, and W. Sheppard. 2005. An evaluation of silvicultural treatments and biomass use to reduce fire hazard in western States. USDA Forest Service. (Draft manuscript)

Zhang, D., J. Buongiorno, and P.J. Ince. 1993. PELPS III: A microcomputer price endogenous linear programming system for economic modeling, version 1.0. Res. Pap. FPL-RP-526. Madison, WI: USDA Forest Service, U.S. Forest Products Laboratory. 43 p.

Zhang, D., J. Buongiorno, and P.J. Ince. 1996. A recursive linear-programming analysis of the future of the pulp and paper industry in the United States: Changes in supplies and demands and the effects of recycling. Annals of Operations Res. 68:109-139.