A Practical Framework for Evaluating Hauling Costs

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ABSTRACT

This study demonstrates the use of an Excel program "Routechaser" to assess the effects of tract location, vehicle operating parameters, operating costs and other physical and economic inputs on the costs of transporting wood products from roadside to mill. The application chosen, a comparison of the effects of trucking costs from four tracts in Oktibbeha County, Mississippi, to eight markets, demonstrates that for forestry, as for any other real estate, value is a function of location. This is especially true if forest management is directed toward lower valued commodity products. Trucking costs were most restrictive on pulpwood, essentially eliminating many markets for several of the tracts. Trucking costs eliminated one market for all quadrants, another market for three, and three markets for one quadrant each.

INTRODUCTION

Mississippi, like most states in the U. S. Atlantic and Gulf South, is heavily forested. Over two-thirds of the land area is classified as "uncultivated" meaning it is either in managed or naturally regenerated forests. These lands play a crucial role in the state's economy with annual harvests in excess of 31,000,000 m^3 (33,000,000 tons) per year. Timber is an important economic resource, the number one agricultural crop in 49 of Mississippi's 82 counties in 1997, and the number two crop in 17 additional counties. Wood in the round accounts for over 25% of the total commodity tonnage moved by truck in the state; over 50% of the rail loadings are forestry related. The associated wood supply system supported roughly 3,000 firms and 30,000 full- and part-time jobs [3].

Keywords: *Log transportation, (log trucks), transportation costs, transportation logistics, road weight limits, road way regulations, Mississippi.*

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Timber only has value if it can be moved from the stump to the mill, and that transport is largely over public highways. Truck transportation is the only means that has the flexibility, versatility, and mobility to meet this challenge and accounts for 40 to 60 percent of harvest and delivery costs. Loggers, in Mississippi, move 1.2 million loads of round wood a year [14]. The logistical dimensions are daunting when one considers that the points of origin are widely dispersed, temporary - used only as long as it takes to cut the timber on a tract, a significant share of the routes is on rural secondary and tertiary roads, and the demand for trucking service is market and weather sensitive.

THE FOREST RESOURCE

The long term welfare of the state's forests and the forest based economy depends on private ownerships and public roads. Eighty-nine percent of the forest is privately owned by individuals, investors, or forest industry. Parcel sizes of these private holdings tend to be small and tracts tend to be scattered; the median size based on count is two hectares (five acres); the median based on area is 16 hectares (40 acres). Parcels are larger on industry or investor owned lands, median size of 24 hectares (60 acres) based on count and 96 hectares (240 acres) based on acreage. (The medians for industry/investor ownerships are probably larger, the above numbers are based on tax records, and most counties treat each section - one mile square block - containing 256 hectares (640 acres) in single ownership - as a parcel even if the owner holds title to adjacent blocks). These larger blocks are usually broken into smaller sale units, holding areas disturbed to an average of 40 hectares (100 acres) or less for management purposes and to comply with the green-up provisions of the Sustainable Forestry Initiative.

Forestry is the lowest economic land use. Most of the forested parcels exist because the soils were considered, or have become, sub-marginal for agriculture, and location rendered them unsuitable for residential, development or other use. The highest and best use has been production forestry, growing trees in expectation of future harvest. Maintaining this use is crucial to rural economies. Forest land is a component of the wealth of the forest owners. Property taxes, tied to land values, are an important part of the revenue base of rural counties, and the jobs provided are an important part of rural economies.

Forest management on private lands is an exercise of faith, faith that markets for the timber grown will be there when the landowner chooses to sell, and that those markets will pay a price that recovers management costs and provides a reasonable rate of return on the investment. This has been the case for Mississippi owners for the last half century, but the past is a weak predictor of the future. Consolidation, globalization, and technological obsolescence have resulted in mill closures and restructuring of markets and procurement areas. This is especially critical for management plans that depend on a ready market for short term commodity products - such as pulpwood from thinnings - at a specific point in time. If that market is not there, the management plan is nullified and the stand, and the associated investment, may be put at risk. Failure to thin a heavily stocked stand, for example, increases the chance of losing the crop to insects and disease.

Standing timber, in a healthy stand, has a relatively low harvest penalty, meaning that there is nothing inherent in the stand or in product price to force a landowner to harvest at a predetermined time. If the stumpage price offered at the time of harvest dictated by the management plan is not to the landowner's liking, the timber will be kept off the market. The trees will continue to grow, and perhaps move into a product class that will command higher stumpage prices which in turn can justify a more costly ride.

THE WOOD SUPPLY SYSTEM

The wood supply system is the merchant and production system that links forest ownerships with markets. It does much more than simply harvest timber. It locates, purchases, harvests, and directs the flow of timber from the thousands of small, scattered tracts to a relatively small set of converting facilities. The wood supply system is a multi-level entrepreneurial system tied to several different industrial systems. The private landowner is an entrepreneur, as is the consultant forester, the logger, the contract trucker, and the wood broker. Industrial systems span the range of wood products firms, pine and hardwood sawmills, oriented strand board, plywood, pulp and paper, as well as smaller, specialty firms. The industrial participants look for predictability; the entrepreneurs look for opportunity.

Harvesting is usually done under a "cut and haul" arrangement where a contract is struck between a landowner, consuming mill, or wood broker and a logging contractor that requires the logging firm to harvest and deliver the timber. The logging contractor usually owns the in-woods equipment, may own and operate the associated truck, may contract out all trucking, or use a mix of his own and contracted trucks.

THE ROAD SYSTEM

Production forestry in Mississippi must deal with a four tiered road system; interstate, federal and state, county, and private. The state has 118,650 kms (73,700 mi) of public roads. Of that, 79,950 kms (49,665 mi), or 67%, are paved. (Pavement here is used in the common American sense meaning a concrete or crushed stone and tar surface.) The remainder, 38,700 kms (24,035mi), is unpaved, but surfaced with native gravel and soil. The Mississippi Department of Transportation maintains 14% or 16,681 km (10,361 mi) of roads. Municipalities are responsible for 17,191 km (10,678 mi) or 15%, leaving the 82 counties responsible for 71% [12]. Private road mileage is unmeasured and of highly variable quality - ranging from permanent, all weather roads built by forest industry through farm roads or tracks to temporary roads "pushed in" to serve a short term need.

The first transport leg, from the landing to a public road, is on one of these temporary, usually private, roads. The distance is usually short, the density of the public road network is such that few tracts owned by individuals are farther than 2 km (1.25 mi) "off highway". Larger public, investor, or industry owned properties have an internal network of serviceable, restricted access roads to join temporary roads with public roads.

The next leg is on the public "secondary or county" road system administered at the local level. The standard of these roads is a product of the budget the county administrators have to work with (which in turn is a function of the size and health of the local economy). The routes available and load weights that can be moved over individual road sections are controlled by local restrictions to protect low weight bridges, road pavements and to satisfy the desires of local citizenry. These "county roads" are largely gravel or lightly paved, nominally two lane roads. Many have evolved from local use in the 19th century and were upgraded and to serve as farm to market roads linking rural residents with market towns or as feeders for state and federal highways. The pavement, alignment, and bridges are suited only for temporary heavy use, are often easily damaged by large trucks.

The third leg, state and federal roads, are at least two-lane, painted center line paved roads. Log trucks can have a maximum gross vehicle weight (GVW) of 37.2 metric tonnes (42 tons) - with a special "Harvest Permit". Speed limits are set according to alignment and congestion with a 90 km p h (55 mph) limit on two lane roads and 112 km p h (70 mph) limit on four lane, divided highways.

The fourth tier, the Interstate Highway system of four lane, limited access, divided highways, allows speeds of 112 km p h (70 mph), but are limited to 36 metric tonnes (40 tons) gross vehicle weight.

The county, state, and federal roads were put in place for people, not timber, and are a product of past settlement patterns and land use as evidenced by the public road network of Oktibbeha County, Mississippi (Figure 1). State and federal roads developed as commercial arteries to link towns and communities as shown by the radial pattern that developed from linking the county seat with the seats of adjacent counties. County roads (Figure 2) developed as local use routes to link people with each other, to provide access to the local administrative or commercial center, and to serve the needs of rural mail delivery. County roads are most dense in those areas with high end (agricultural, commercial and residential) land use, tend to meander, and enter sparsely populated areas dominated by forests only when necessary. The reduced density of county roads along the northern and southern boundaries of the county occurs because these areas, once farmed, have reverted to forest and the county road maintenance ceased as population declined. Many of the old road beds are still used, but are now privately maintained.

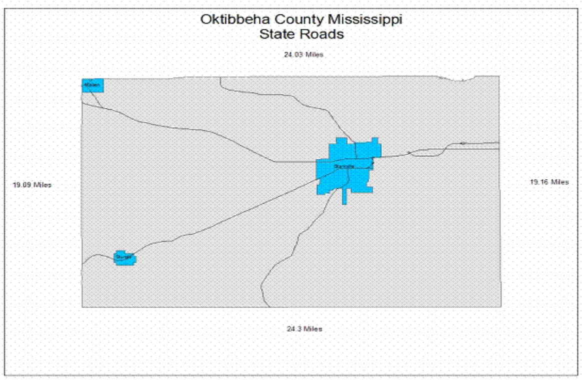

Figure 1. Federal and state highways of Oktibbeha County, MS.

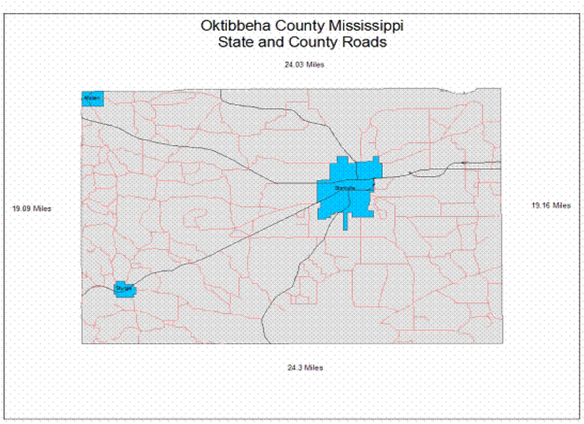

Figure 2. All public roads and tract locations in Oktibbeha County, MS._that are used in the analyses.

County roads fall completely under the purview of county administrators; construction, maintenance and repair consume a considerable share of county budgets and are a common source of citizen complaints concerning dust on unpaved roads, damage to pavements, noise, and congestion. This is not a strictly Mississippi phenomena; there was a 350% increase from 1988 to 1992 in the number of Georgia counties having regulations that affected logging operations. These regulations included such items as truck weight, hauling permits and keeping mud off paved roads [6].

By law, log trucks can move from the tract being harvested to the nearest state or federal highway over the county system by the shortest route - providing that route does not cross a low weight bridge, will not damage existing pavement, or pose a major problem for the citizenry along that route. Many counties require loggers and other commercial users of their roads to consult with the county supervisor or county engineer and get a formal permit, or have the route they propose to use approved or an alternate specified.

The initial segments of the haul determine the load for the entire trip [6]. Several counties in recent years have proposed reducing weight limits on roads they control as a strategy for reducing maintenance costs. Some proposed an older state mandated gross vehicle weight (GVW) limit of 32.3 metric tonnes (73,280 lbs), others an even older state limit of 25.9 metric tonnes (57,560 lbs), and one adventurous county a limit of 18 metric tonnes (40,000 lbs). Complying with the 25.9 metric tonne (57,560 lbs) and 18 metric tonne (40,000 lbs) limits would require a conversion from tractor-trailer combinations to straight trucks; the effects of those changes are being explored but will not be discussed here.

Grace [4,5], found that two north Mississippi counties (Alcorn and Lafayette) would lose $4 million and $7 million/year in stumpage payments, respectively, by lowering the road weight limits on county roads from 36 metric tonnes (80,000 lbs) (GVW) to 25.9 metric tonnes (57,560 lbs), and that reduction would in turn affect land values as tax revenues. While it may or may not be true that all politics are local, the feasibility of forest management practices is definitely local. The profitability of any forest management plan is a function of the presence or absence of a low cost and efficient transportation network [13].

STUMPAGE PRICES

The market theoretically treats stumpage, the price the landowner receives for timber, as a residual - the amount remaining after harvesting and transportation costs are subtracted from the price paid at the converting facility. Distance is the dominant variable and time the dominant resultant in determining cost [1] . Simple cartographic or crow-flight distances are often extended by natural and anthropomorphic features and affected by regulatory forces. Road quality, bridge limitations, and county regulations, road use and congestion can have a drastic effect on hauling distance, time and ultimately cost.

This is especially true in Mississippi with over three-quarters of the forest area in private, non-industrial ownership, management ranges from intensive to extensive, tract sizes are variable, and moves common, where species and tree size mix within a tract is determined by minor topographic differences, and weather conditions for much of the year cause rapid deterioration of harvested timber. Logging is "hot", with wood moved to the market immediately after severance, and trucking is closely integrated with harvesting.

"Cut-and-haul" contractors work under a tract by tract contracting agreement. Mechanization has overwhelmed many of the traditional determinants of harvesting productivity - species, tree size, skid distance, etc - but the accompanying move to forest to mill transportation has increased the effects of transportation on overall job performance. Contractors are paid on delivered volume; their weekly and monthly revenues are dependent on their ability to move the wood to market as quickly and efficiently as possible.

Haul routes change with each tract; markets may change depending on the species, tree size, and the needs of individual mills. It is not unusual for a logger to have trucks moving to two or more mill locations from a single tract on a single day. Scheduling, coordination, and cost of transportation are keys to economic survival. Margins have narrowed as markets for services have tightened, and the need for a more refined understanding of the factors affecting transportation and their influence on overall business performance on the part of both contractors and contracting firms has increased.

METHODS

Modeling Approach

We developed an EXCEL based, open form, deterministic model, "Routechaser", to reflect the effects of tract location (including route from the tract to selected markets and road standards along that route), vehicle operating parameters (including allowable gross vehicle weight and speed), operating costs (including the costs of equipment, labor, consumable supplies, repair and maintenance), scheduling parameters (days worked per year, scheduled hours per day, allowable overtime, and hours of service), and other physical and economic inputs to generate cost per ton mile, cost per ton, delivered loads, volume per day, and daily cost of operation by tract/market combination, and outlays per day by expenditure type using the above inputs. The model includes a provision for saving the input parameters and outputs for individual executions in an Excel spreadsheet for secondary analyses. The model format was kept uncomplicated to allow its use by logging contractors, trucking contractors and procurement foresters as a tool for planning routes and estimating hauling costs.

Model Application

A demonstration application from a larger comparison of the effects of trucking regulations on stumpage prices for four Mississippi counties will be used to show the differences in cost and productivity of moving wood from four tracts in Oktibbeha County, MS to a set of eight markets. Factors considered include: the difference in delivered cost per metric tonne (or short ton) by tract and market, the difference in costs for new and used equipment, and how costs are affected by reduced weight limits. All other parameters were, therefore, held constant. For simplicity, only the technical variation affecting an operation (the performance of equipment as a function of the interaction between the machine and the operating environment), and no attempt has been made to mitigate technical inefficiency with administrative corrections. All loads go to only one market; no effort was made to mix routes to optimize scheduled hours, and all loads were to be completed in the same day or shift.

Program Variables

A "Routechaser" input table with the parameters used for the base case scenario is shown in Figure 3. These parameters were developed from the job records of Northeast Mississippi loggers, from trucking studies [2, 7, and 9], and cost and productivity studies [8, 11, and 17], as well as the cost index study being conducted for the Wood Supply Research Institute [14, 15, and 16]. The objective of this application was analytical, comparing the effects of markets, equipment age, and weight limits on hauling cost, rather than predictive. Consequently, the effort was to assemble a representative rather than a specific set of parameters.

Oktibbeha County, introduced in Figures 1 and 2, was used as the base location. The county is rectangular, 30 by 39 km (19 by 24 miles), 55% forested, with the county seat of Starkville in the central north (Figure 1). State and federal roads radiate from this civil center. The road pat-

Scheduling	
Work Days per Year	182
Hours per Day	8
Allowable Extra Hours	2.5
Overtime (Y/N)	N
Equipment	
Gross Vehicle Loaded Weight (lbs)	84,000
Vehicle Tare Weight (lbs)	30,000
Costs	
Equipment Purchase Price	
Truck tractor	88,000
Trailer	15,000
Add ons, taxes, equipment	15,450
Total Cost	**118,450**
Financing	
Amount	$118,450
APR	8.75%
Years	3
Labor	
Base Wage/Hour	$11.00
Fringe Benefits + WC Percent	35%
Fuel	
Cost per Gallon	$1.48
Insurance	**Per Year**
Liability	$3,000
Collision/FTV	$850
Overheads	**Per Year**
License - Apportioned Tags	$1,600
Ad Valorem Taxes	$3,500
Heavy Use Tax	$450

Route

Road type	Miles	Speed MPH	Fuel MPG
Forest Road	0.5	8	2.0
Gravelled County Road	5	30	2.8
Paved County Road	9	40	3.6
State or Federal 2 Lane Highway	25	45	5.0
Limited Access Highway	10	60	5.0
Urban Streets	4	20	2.3
Total Travel Distance	53.5		

Turnaround and Delays

Turnaround	
Woods Wait - Minutes/Trip	30
Mill Wait - Minutes/Trip	30
Delays	
In Route Delay - Minutes/Trip	30
Daily Service - Minutes/Trip	30

Repair and Maintenance
Limited Access Highway as Base

	Per mile	Limited Access	Forest Road	Gravelled County	Paved County	State 2 Lane	Urban Streets
Brakes	$0.05	100%	200%	150%	150%	125%	150%
Tires	$0.14	100%	200%	150%	175%	100%	100%
Normal Maintenance	$0.01	100%	200%	175%	150%	125%	125%
Minor Repair	$0.02	100%	200%	150%	150%	100%	125%

Figure 3. Routechaser input form showing parameters used in the demonstration analyses.

tern is such that much of the timber harvested in the county must travel through the town. The county has one four-lane federal highway, crossing the county from East to West. Three state routes, one four-lane entering from the south, one two-lane from the southwest, and another two lane from the north, focus on the town.

County maintained roads (Figure 2) illustrate the effect of past and current land use on public road density. Much of the county was cleared by the late 19th century and put in agriculture - first cotton production and then dairy farming. Marginal sites reverted back to forest as agriculture declined. The areas lacking public roads in the south central portion of the county were once settled but were incorporated into the Noxubee National Wildlife Refuge and the John Starr Memorial Forest in the mid 20th century. Similarly, other lightly roaded areas are in corporate forest, wildlife management areas or private ownerships which have assumed responsibility for internal roads.

Markets and Tracts

Eight markets were selected from those drawing wood from the county (Figure 4). Market 1 is a an oriented strand board mill using pulpwood sized material, Market 2 is a kraft pulp mill, Market 3 is a sawmill producing both grade and dimension pine lumber, Market 4 is a Kraft pulp mill and small log dimension mill, Market 5 is a pine sawmill and chip mill, Market 6 is a pine sawmill and plywood plant, Market 7 is a chip and saw mill and a reloading point for pine pulpwood, and Market 8 has a thermo-mechanical pulp mill, an oriented strand board plant and pine and hardwood sawmills in close proximity. There are other markets available, at greater or lesser distances, but they were excluded to avoid over complicating the application.

Four forested tract locations were selected at random from the county tax records, one each in the northeast (NE), southeast (SE), northwest (NW), and southwest (SW) quarters of the county. Mapquest[c], an on-line service of MSN, was used to identify the shortest haul route from each of the four tracts to the eight different facilities. Any similar mapping program or technique may be used. Each route was checked to avoid segments that limited commercial traffic or involved crossing low weight bridges. Alternate routings were developed in each instance where this occurred. The routes were then segregated into one-way mileage by road standard or type as shown in Table 1.

Weight Limits

The Gross Vehicle Weight (GVW) limit for the new and used tandem axle tractor trailer trucks of 38,200 kg (84,000 lbs), 36,280 kg (80,000 lbs) legal weight plus a 5% tolerance allowed under Mississippi law with the purchase of

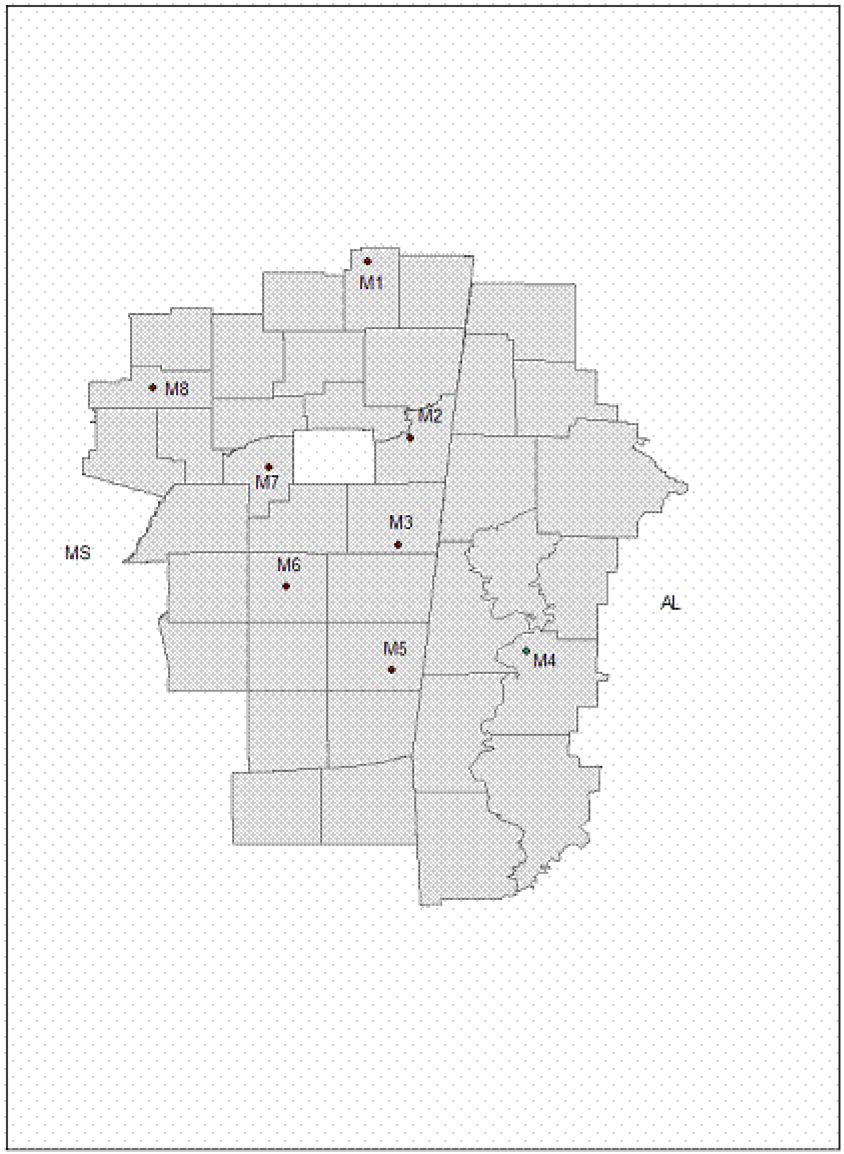

Figure 4. Market locations for wood harvested from Oktibbeha County, MS.

a harvest permit, was used as the base case. (None of the routes called for interstate highway travel where a maximum GVW of 36,280 kg (80,000 lbs) would have applied.) A tare weight of 13,600 kg (30,000 lbs) was used for the new and used tandem axle tractor trailer trucks, resulting in a net payload of 24,500 kg (54,000 lbs). A lower weight of 31,800 kg (70,000 lbs) was used to estimate the effect of locally imposed weight limits.

New Versus Used Equipment

The price and financing for a new tractor and log trailer was based on a phone survey of local Mack, Freightliner, International, and Volvo dealerships in April 2004, request-

Table 1. Markets, tract or origin, and distance (mi) by road type.

Market Direction	Quadrant of Origin	One-Way Mileage by Road Type: Country Gravel	Country Paved	State 2-lane	Limited Access	Urban	Total
M1	NE	0	11	2	106	2	120
North	SE	0	13	2	119	1	135
	SW	0	5	25	121	9	159
	NW	0	3	2	138	4	146
M2	NE	0	20	0	36	1	57
East	SE	0	28	0	45	0	73
	SW	0	15	23	42	8	88
	NW	0	13	0	64	3	81
M3	NE	0	11	0	66	0	77
Southeast	SE	0	10	0	40	2	52
	SW	0	5	23	71	8	106
	NW	0	3	0	94	3	99
M4	NE	0	24	40	130	0	194
South-Southeast	SE	0	23	40	104	2	169
	SW	0	20	141	74	0	236
	NW	0	16	40	157	3	216
M5	NE	0	11	0	148	2	161
South	SE	0	10	0	123	3	135
	SW	0	20	102	39	2	163
	NW	0	3	0	175	5	183
M6	NE	0	12	98	0	11	120
South-Southwest	SW	4	23	48	0	19	93
	SW	0	20	44	0	6	70
	NW	0	3	87	10	6	107
M7	NE	0	11	38	0	5	54
Southwest	SE	0	25	29	0	0	54
	SW	0	45	17	0	2	64
	NW	0	4	23	10	0	38
M8	NE	0	11	2	142	2	157
Northwest	SE	0	17	2	129	8	156
	SW	0	26	2	108	3	139
	NW	0	3	2	113	2	120

ing base prices for models commonly sold to loggers as well as special equipment and options, taxes, and financing packages offered. These were averaged to an $88,000 cost for the tractor, $15,000 for the trailer, $15,450 for add-ons such as cab protectors, and taxes for a total cost of $118,450.

Jackson [8] found that the average age of log trucks for loggers in his study was five years, the oldest 25 years. The US Internal Revenue Service allows full depreciation of a truck tractor in three years; Jackson's five year average reflects a tractor fully depreciated by a long distance common carrier or owner operator that was retained for an additional year or two before being traded. The price of a five-year-old used tractor trailer was based on the same survey of dealerships used for new equipment and was set at $28,840, including a used truck at $25,000, a used trailer at $3,000, and add-ons at $840. Fuel consumption was increased 10% to reflect the inefficiencies of older equipment. Brakes, tires, normal maintenance, and wear and tear costs were double those of new equipment.

RESULTS

Each replication of four tracts, eight markets, one equipment type, and a single weight limit resulted in 32 permutations. Performance parameters - speed by road type, loading and unloading time, pre-trip and driver rest times and the like - can be easily varied but were held constant for this exercise.

Markets and Tracts

The one way distance, loads per day and the worked hours per day by market and tract for the base case are shown in Table 2. An interesting pattern emerges (Figure 5); equipment and driver utilization (in terms of hours per day) tends to increase as expected on haul distances of 32 to 128 km (20 to 60 mi) but utilization within those bounds is affected by tract and market combinations - the roads over which the truck travels. The route effects are moderated at longer distances, 128 to 250 km (60 to 120 mi). Beyond 132 km, distance alone is the major influence. The effect of road standard and crossing through the urban area can be seen in the three observations between 121 and 132 km (75 and 85 mi). The two higher utilization observations were for two routes, NE to M1 and NW to M8, that avoided the urban area with most of the route on limited access highway. The lower observation, NE to M5, was all on state and county roads and had to pass through the town.

The base case cost per metric tonne by haul distance relationship for new equipment using the operating parameters above (Figure 6) for the population is a step function, with costs stepping up between 50 and 60 km and between 110 and 160 km; points where the combination of road standard and distance determine the loads per day (Figure 6). The spread of cost among markets by quadrant was narrowest for the Southeastern quadrant and narrowest ($16.83) and widest for the Southwestern quadrant ($20.24), despite the best effort to keep the range of distances to market relatively constant among quadrants of origin (Table 3). Wood from the SW going to M1, which must pass through the town, for example, is $9.15/metric ton more costly than that from the NE quadrant, which does not. The difference in one-way distance on the two hauls was 32.23 km (20 mi).

New Versus Used Equipment

The hauling costs generated for the base case were well above those currently being paid, a practical reflection of why Jackson [8] found the average truck age to be five years; the cost structure favors used equipment. Reducing capital investment 75% by modeling a used truck costing $28,840 instead of a new one at $118,450 while reducing fuel efficiency to 90% and doubling repair and maintenance costs resulted in the costs shown in Table 4. The new and used trucks were assumed to be equivalent in travel speed, load capability, and dependability.

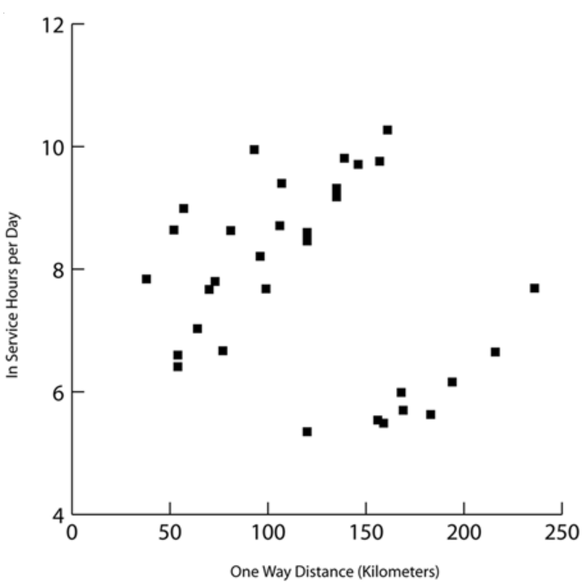

Figure 5. Truck and driver hours in relation to haul distance (km).

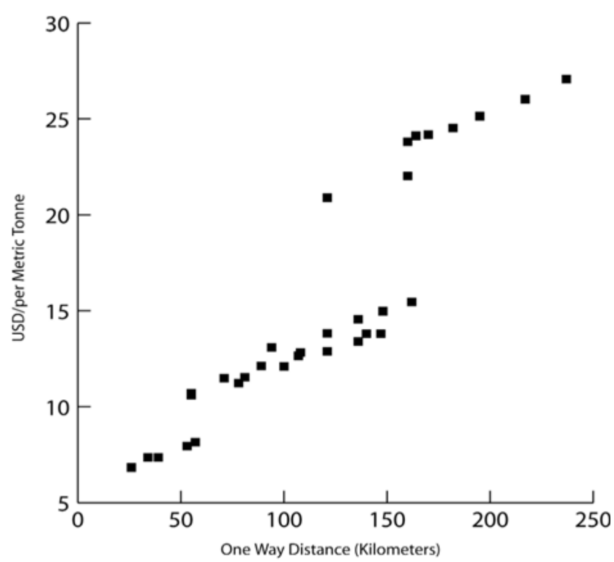

Figure 6. Base case hauling cost (USD per metric tonne) by distance (km).

Table 2. Loads per day, truck and driver utilization by market and tract.

	Source Quadrant			
Market	NE	SE	SW	NW
	One-Way Distance -Kilometers			
M1	119.95	134.60	158.59	146.03
M2	57.16	73.26	95.63	80.82
M3	77.28	51.84	106.26	99.34
M4	194.01	168.57	235.87	215.58
M5	160.84	135.40	168.08	182.90
M6	120.43	93.38	70.36	106.58
M7	54.26	54.26	64.08	38.00
M8	157.30	155.53	139.10	119.95
	One-Way Distance -Miles			
M1	74.50	83.60	98.50	90.70
M2	35.50	45.50	59.40	50.20
M3	48.00	32.20	66.00	61.70
M4	120.50	104.70	146.50	133.90
M5	99.90	84.10	104.40	113.60
M6	74.80	58.00	43.70	66.20
M7	33.70	33.70	39.80	23.60
M8	97.70	96.60	86.40	74.50
	Loads per Day			
M1	2	2	1	2
M2	3	3	2	2
M3	2	3	2	2
M4	1	1	1	1
M5	2	2	1	1
M6	1	2	2	2
M7	2	2	3	3
M8	2	1	2	2
	In Service Hours			
M1	8.60	9.18	5.49	9.71
M2	8.99	7.80	8.21	8.63
M3	6.67	8.64	8.71	7.68
M4	6.16	5.70	7.69	6.65
M5	10.27	9.32	5.99	5.63
M6	5.35	9.95	7.67	9.40
M7	6.60	6.41	7.03	7.84
M8	9.76	5.54	9.81	8.46

Overall, reducing capital costs by 75% reduced hauling costs by about one-quarter, although the savings varied among tract and market combinations as shown in Table 5. The cost per unit reduction from controlling capital costs was generally greater on shorter hauls, where capital cost is a great share of total costs, and where the driver had the option of making an additional load each day by "pushing" the scheduled hours limit such as those to M2, M3, and M7.

Lowered Weight Limits

The cost per tonne increases associated with reducing the gross vehicle weight from 36,280 kg (80,000 lbs) to 31,500 kg (70,000 lbs) are shown in Table 6 for both the new and used equipment. The increases were predictably greater for new trucks, underutilizing high cost equipment is more costly than underutilizing cheaper trucks.

The sensitivity of lower value forest products to factors that affect hauling costs was demonstrated by assessing the residual left after transportation costs were subtracted. Four equipment permutations were used - new and used trucks with a full payload (36,280 kg), and new and used trucks each with payloads of 31,500 kg. The used truck - 36,280 kg load - was the least expensive for all permutations and is the most common in the region so was used as the basis for comparison. The cost per metric tonne for this "base" equipment option was subtracted from the cost for alternative equipment - GVW combination for each origin - market combination

Summer 2004 stumpage prices per metric tonne from several price reporting services were averaged to $9.89 for pulpwood, $26.37 for chip and saw, and $45.95 for sawtimber. The trucking costs per metric tonne generated by "Routechaser" for the used equipment - 36,280 kg combination - was subtracted from those for the other equipment to arrive at a "premium" cost for that alternative. The premiums were then subtracted from the reported stumpage value to arrive at a residual value, for each origin-market combination by product. The result was then expressed as a percentage of initial prices.

Not surprisingly, the results, Figure 7, show that pulpwood, the lowest valued material form, has the greatest volatility. This is due in part to the smaller divisor used in computing the percentage and because several of the markets were suspected of being infeasible pulpwood markets when structuring the analysis. Only 13 of the 128 pulpwood permutations would support a stumpage price of 80% or more of the base price. Fifty-two permutations resulted in negative stumpage. The estimated hauling cost was more than the published stumpage price.

Table 3. New truck costs (USD) per metric tonne by market and quadrant of origin.

	Market	Quadrant of Origin				Variation Across Origins		
		NE $	SE $	SW $	NW $	Lowest $	Highest $	Spread $
	M1	12.88	13.40	22.03	13.81	12.88	22.03	9.15
	M2	8.15	7.35	12.12	11.53	7.35	12.12	4.77
	M3	11.23	7.95	12.65	12.09	7.95	12.65	4.71
	M4	25.14	24.18	27.08	26.02	24.18	27.08	2.90
	M5	15.46	14.56	24.12	24.53	14.56	24.53	9.97
	M6	20.89	13.08	11.49	12.83	11.49	20.89	9.40
	M7	10.69	10.60	6.83	7.36	6.83	10.69	3.86
	M8	14.98	23.81	13.80	13.82	13.80	23.81	10.02
Variation across markets	Low	8.15	7.35	6.83	7.36			
	High	25.14	24.18	27.08	26.02			
	Spread	16.98	16.83	20.24	18.66			

Table 4. Cost (USD) per metric tonne for the used truck alternative.

	Market	Quadrant of Origin				Variation Across Origins		
		NE $	SE $	SW $	NW $	Lowest $	Highest $	Spread $
	M1	9.72	10.33	16.16	10.79	9.72	16.16	6.44
	M2	5.80	5.08	8.78	7.55	5.08	8.78	3.69
	M3	7.79	5.55	9.37	8.78	5.55	9.37	3.83
	M4	19.20	17.91	21.59	20.30	17.91	21.59	3.68
	M5	12.24	11.18	17.73	18.35	11.18	18.35	7.17
	M6	14.55	9.78	8.04	9.53	8.04	14.55	6.50
	M7	7.11	7.06	4.56	4.89	4.56	7.11	2.55
	M8	11.74	17.36	11.58	10.32	10.32	17.36	7.05
Variation across markets	Low	5.80	5.08	4.56	4.89			
	High	19.20	17.91	21.59	20.30			
	Spread	13.40	12.83	17.03	15.41			

Table 5. Cost (USD) per metric tonne for the used truck as a percentage of that for the new truck.

	Market	Quadrant of Origin				Variation Across Destinations		
		NE %	SE %	SW %	NW %	Lowest %	Highest %	Spread %
	M1	75	77	73	78	73	78	5
	M2	71	69	72	65	65	72	7
	M3	69	70	74	73	69	74	5
	M4	76	74	80	78	74	80	6
	M5	79	77	74	75	74	79	6
	M6	70	75	70	74	70	75	5
	M7	67	67	67	66	66	67	0
	M8	78	73	84	75	73	84	11
Variation across markets	Low	67	67	67	65			
	High	79	77	84	78			
	Spread	13	10	17	13			

Table 6. Cost (USD) per metric tonne increase for new and used trucks arising from a 6,300 kg reduction in gross vehicle weight.

New Truck

	Market	Quadrant of Origin				Variation Across Origins		
		NE	SE	SW	NW	Lowest	Highest	Spread
	M1	$4.49	$4.67	$7.68	$4.82	$4.49	$7.68	$3.19
	M2	$2.85	$2.57	$4.24	$4.02	$2.57	$4.24	$1.67
	M3	$3.92	$2.78	$4.41	$4.22	$2.78	$4.41	$1.63
	M4	$6.27	$6.03	$6.76	$6.48	$6.03	$6.76	$0.73
	M5	$3.86	$3.63	$6.02	$6.12	$3.63	$6.12	$2.49
	M6	$7.30	$4.56	$4.01	$4.47	$4.01	$7.30	$3.29
	M7	$3.74	$3.70	$2.38	$2.57	$2.38	$3.74	$1.35
	M8	$3.74	$5.93	$4.81	$3.45	$3.45	$5.93	$2.48
Variation Across Markets	Lowest	$2.85	$2.57	$2.38	$2.57			
	Highest	$7.30	$6.03	$7.68	$6.48			
	Spread	$4.45	$3.46	$5.30	$3.91			

Used Truck

	Market	Quadrant of Origin				Variation Across Origins		
		NE	SE	SW	NW	Lowest	Highest	Spread
	M1	$3.12	$3.30	$4.93	$3.44	$3.12	$4.93	$1.81
	M2	$1.93	$1.65	$2.85	$2.65	$1.65	$2.85	$1.20
	M3	$2.55	$1.86	$3.03	$2.84	$1.86	$3.03	$1.18
	M4	$4.14	$3.90	$4.62	$4.36	$3.90	$4.62	$0.71
	M5	$2.79	$2.56	$3.89	$3.99	$2.56	$3.99	$1.43
	M6	$4.54	$3.19	$2.63	$3.10	$2.63	$4.54	$1.91
	M7	$2.35	$2.32	$1.46	$1.65	$1.46	$2.35	$0.89
	M8	$2.67	$3.81	$2.65	$2.38	$2.38	$3.81	$1.43
Variation Across Markets	Lowest	$1.93	$1.65	$1.46	$1.65			
	Highest	$4.54	$3.90	$4.93	$4.36			
	Spread	$2.60	$2.25	$3.47	$2.71			

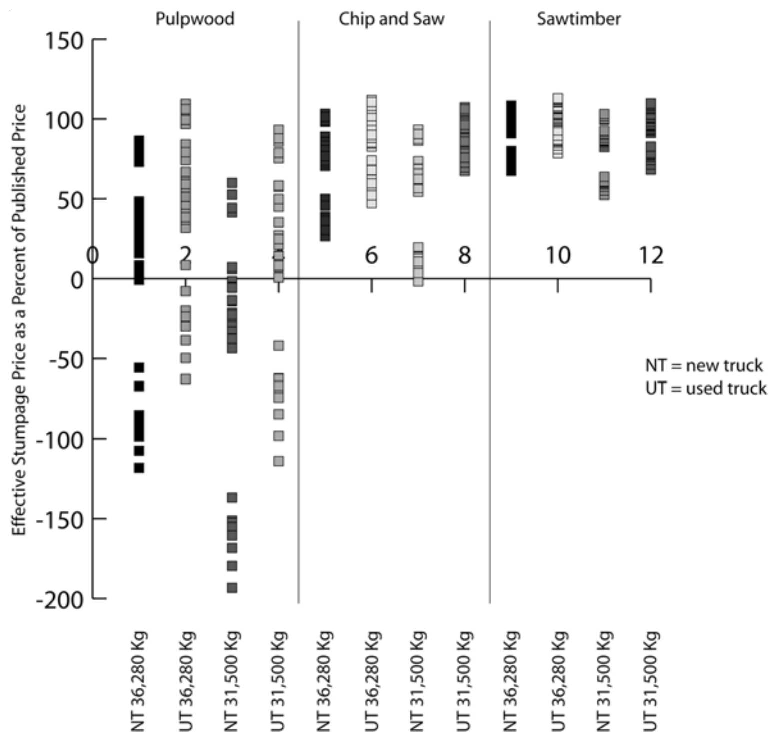

Figure 7. Residual stumpage prices as a percent of published price.

The ranges narrowed, for chip and saw material, the maximum stumpage reduction was to zero, 68 of the 128 permutations were greater than 80 percent of the base. The transportation allowance for saw timber was such that that the largest reduction was 52% of base price and 101 of the 128 permutations were greater than 80%.

DISCUSSION

Wood supply in the US South is dependent on private timber and public roads. Tracts to be harvested are distributed over the landscape and commonly produce a variety of products that must be transported to dispersed markets. Harvesting and transportation performance are closely linked by the business system - payment is made on the volume delivered, risk of wood degradation-especially during summer months, weather uncertainty, and the need to keep woods landings small. Operations move frequently because of tract size (volume harvested), weather, or market conditions. Time on tract is usually measured in days, not weeks.

Trucking costs commonly comprise 40% or more of the combined "cut and haul" costs. Logistics planning and management are constant challenges in this environment. Each tract represents a new set of routes, possibly to different markets, different political entities, and regulations.

"Routechaser" is intended as a tool for evaluating the effect of equipment, roads and loads on the cost of moving wood from one tract to one market over one route, and then using the results as a basis for exploring alternate strategies. It is intended as a planning tool for use in evaluating the effects of routes, equipment and regulations on truck performance and costs.

The example set forth demonstrates that stump to mill distance is an incomplete estimator of trucking costs. Long hauls on low speed roads and start and stop traffic affect total trip time, trucking cost and truck productivity. The need to pass through an urban area added several dollars per tonne (and ton) to the hauling cost.

There is constant pressure to reduce cut and haul rates. The consuming mill sees this as a way to reduce raw material costs; the landowner as a way to increase stumpage price. The ability to cut costs operationally is limited by the dynamics of the transportation system; variable demand always creates a situation of too many or too few trucks at any given time. A common strategy is to rely on older or second hand trucks. The leverage gained is limited. Cutting capital investment by 75% only reduced cost per tonne by 25% in the simplified scenario assuming equivalent performance and reliability as used here. These savings would be further diminished if the potential costs of breakdowns or accidents were included.

Highway regulations such as speed and weight limits have the greatest effect on low valued products and higher capital equipment. In this application, and in reality, maintaining stumpage values at published rates is dependent on used or fully depreciated trucks. This poses an interesting question. Should the protection of the equity of one group of entrepreneurs-forest landowners-depend on the consumption of the equity of others-loggers or contract truckers? Older equipment is less dependable, and, even with excellent maintenance, poses an increased safety risk. Wylezinski [18] states, “log vehicle accidents are a major concern because they expose businesses to additional liability and cause injury or death”. Meyer [10] found that log truck accidents account for about 11 percent of all deaths related to the logging profession. Log trucks tend to be several years older than other trucks on the road. As a result, they have a higher percentage of brake failures, steering failures, improper lighting, and tire tread wear [6].

The use of the residual model for establishing stumpage prices has encouraged foresters (land managers) to promote short term strategies for reducing harvesting and hauling costs without considering short term savings that may result in greater long term costs. Used trucks are a part of that strategy.

There is an important difference between landowners and contractors. Capital invested in timber is committed for the long term - the rotation age of the stand. Capital invested in logging and trucking equipment is committed for the short term - the life of the loan or the depreciation period used for tax purposes - and is therefore more mobile. Services may be withdrawn if rewards are not commensurate with risks. The market will work, in time, but the adjustments could be messy and painful for the participants.

CONCLUSIONS

“Routechaser”, an Excel based program for estimating trucking cost, can be a useful tool for contractors and procurement foresters in establishing contract rates for specific tracts to specific markets. It can also be a useful tool for land managers developing management plans for an individual landowner.

The application dealt with the sensitivity of hauling costs and ultimately stumpage prices to tract location, market location, new and used equipment and truck weight limitations. Tract location, and especially the need to traverse an urban area, affected market accessibility. Timber is a long term investment, and the value of timber at time of harvest will be a function of the transportation network available at time of harvest, not the one in place at the time of stand establishment.

Current stumpage rates, and land values, are dependent on the use of older trucks. The risks associated with this strategy should be more fully evaluated. The cost of mechanical inefficiency, lowered reliability, and increased risk of mechanical failure caused accidents fall on the logging or trucking contractor in the short term but will ultimately be passed to the landowner in the form of reduced stumpage prices or tightened restrictions on road use.

Truck weight limits are lower in the US than in most globally competitive countries. Reducing these further by local ordinance or regulation will only further reduce the ability of domestic products to compete in the market place, which in turn will reduce stumpage values and ultimately land prices.

Forest to market transport is a critical component of production forestry, deserving of more attention than it has received in the southern US. The transport domain is constantly changing, rural populations change both in number and characteristics, roads are improved, and traffic patterns adapt to community development. Society’s pursuit of lowered costs, increased environmental protection, and improved personal safety will continue. The only way to meet the challenge is through improved knowledge.

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REFERENCES

[1] Asikainen, A. and P.J. Kuitto. 2000. Cost factors in wood fuel procurement. Conventional Systems for Bioenergy. IEA Bioenergy Task 18 workshop, Charleston, South Carolina, USA, 19-25, September 1999. New Zealand Journal of Forestry Science. 30:1-2, 79-87.

[2] Beardsell, M.G. 1986. Decreasing the Cost of Hauling Timber Through Increased Payload. Masters Thesis. Virginia Polytechnic Institute and State University. Blacksburg, VA.

[3] Grace, L.A., J.B. Auel and W.B. Stuart. 2003. Attitudes and perceptions of logging contractors, foresters, and other participants in the wood supply system towards education and training opportunities. Skogforsk Arbetsrapport Nr. 538. pp. 29-38. Uppsala, Sweden.

[4] Grace, L.A. 1997a. The Effect of Changed Road Weight Limits on Alcorn Timber Values. Publication No. MTN3D. Mississippi Cooperative Extension Service, Mississippi State, MS. Pamphlet.

[5] Grace, L.A. 1997b. The Effect of Changing Road Weight Limits on Lafayette County Timber Values. Publication No. MTN4D. Mississippi Cooperative Extension Service, Mississippi State, MS. Pamphlet.

[6] Greene, W.D. and B.D. Jackson. 1993. Local Regulations of Timber Harvesting and Trucking in Georgia. Southern Journal of Applied Forestry. 17(4): 200-206.

[7] Horn, C.R. 1999. Evaluating Log Truck Trip Time. Masters Thesis. Mississippi State University.

[8] Jackson, B.D. 2003. Examining the performance of independent harvesting firms in the eastern United States. M.S. Thesis. Mississippi State University.

[9] McCormick, R.J. 1990. Measuring and Evaluating Log Truck Performance in a Variety of Operating Conditions. Ph.D. Dissertation. Virginia Polytechnic Institute and State University.

[10] Meyer, R. 1996. Logging Fatalities in the United States: 1980 - 1988. American Pulpwood Association Technical Release 96-R-45. APA, Rockville, MD. Pamphlet.

[11] Miller, T.L. 1999. The Effects of Production and Cost Changes on Business Performance of Logging Operations, M.S. Thesis. Mississippi State University.

[12] Mississippi Department of Transportation (MDOT). 2002. "The First Roads". www.gomdot.com. Accessed 5/23/2002.

[13] Murray, A.T. 1998. Route Planning for Harvest Site Access. Canadian Journal of Forest Research. Ottawa, National Research Council of Canada. 28(7): 1084-1087.

[14] Stuart, W.B., L.A. Grace, and C.B. Altizer. 2004. Final 2002 Logging Cost Indices and 2003 Update. Fourth Quarterly Report to the Wood Supply Research Institute. Forest and Wildlife Research Center, Mississippi State Univ. Starkville, MS. 14 pp.

[15] Stuart, W.B., L.A. Grace, and C.B. Altizer. 2003. Preliminary 2002 Logging Cost Indices and Demographics of Participating Firms. Third Quarterly Report to the Wood Supply Research Institute. Forest and Wildlife Research Center, Mississippi State Univ. Starkville, MS. 30 pp.

[16] Stuart, W.B., L.A. Grace, B.D. Jackson and R. Stutzman. 2003. Logging Cost Indices. First Quarterly Report to the Wood Supply Research Institute. Forest and Wildlife Research Center, Mississippi State Univ. Starkville, MS. 23 pp.

[17] Stutzman, R.E. 2003. A long term cost and productivity study of logging contractors within the eastern United States. M.S. Thesis. Mississippi State University.

[18] Wylezinski, A. 1993. Extra-Light Log Trailer Design. Ph.D. Dissertation. Virginia Polytechnic Institute and State University, Blacksburg, VA. 133p.