Adapting to a Changing Landscape: How Wisconsin Loggers Persist in an Era of Parcelization

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Abstract

The average forest landowner in Wisconsin owns fewer than 30 acres, and in 2014, landowners with as few as 10 acres of forestland were eligible to enroll in a tax program that required periodic timber harvests. These factors point to a need for loggers capable of profitably harvesting small parcels of timber. A series of in-person interviews were conducted with representatives of 15 Wisconsin logging firms previously identified as successful at harvesting small parcels of timber. Ninety-two percent of mechanized loggers had harvested parcels of 10 acres and smaller within the past year. Eighty-five percent of mechanized loggers were willing to harvest parcels as small as 5 acres assuming that only a short move (<5 mi) was required between timber sales. The average direct moving cost for mechanized loggers was $406 per move, versus an estimated $778 when the costs of idle employees and equipment are included. Seventy-seven percent of the participants in this study purchased at least half of the timber that they harvested, and 85 percent performed services other than timber harvesting, such as establishing food plots, as a procurement tool. This study demonstrates that properly equipped Wisconsin loggers are profitably harvesting small parcels of timber; however, loggers and other timber buyers must recognize the additional costs associated with these harvests and adjust stumpage rates to compensate for these costs.

Parcelization is the process by which relatively large forest ownerships are divided into smaller ownerships (Rickenbach and Gobster 2003). There are a number of factors that drive parcelization in the United States, such as a growing population, intergenerational transfers of forestland, and the divestment of forestland by the forest industry. In 2006, the average family forest landowner in the United States owned only 25 acres (Butler 2008). Land ownership trends in Wisconsin are similar to those for the United States as a whole. In 2009, the average family forest landowner owned just 26 acres (Perry et al. 2012).

Parcelization can have negative impacts on forest management and the forest resource. It is well documented that owners of small parcels of forestland are less likely to invest in forest management than landowners with large parcels (Straka et al. 1984, Romm et al. 1987) and the likelihood of commercial forestry taking place is inversely proportional to population density (Wear et al. 1999). For these and other reasons, the 2010 Resources Planning Act Assessment lists the combination of urbanization and low-density development as one of seven major challenges to sustainably managing the forest resource (US Department of Agriculture Forest Service 2012).

Harvesting costs are typically higher on small parcels of timber than on large ones because fixed costs, such as moving costs, are spread across small harvest volumes (Row 1978, Cubbage 1983, Rickenbach et al. 2005). Cubbage (1983) suggested that costs increase rapidly on parcels smaller than 50 acres and may become prohibitive on parcels smaller than 20 acres. Rickenbach et al. (2005) advised that, in Wisconsin, a timber sale may need to be at least 20 acres to attract the attention of most harvesting firms.

Research in South Carolina found that the percentage of timber harvests conducted on parcels smaller than 40 acres increased from approximately 40 percent in 1998 to nearly 65 percent in 2008 and was projected to increase further (Moldenhauer and Bolding 2009). A similar trend was reported by consulting foresters across the southern United States (Conrad et al. 2010). In response to parcelization, many South Carolina loggers reduced the size of their workforce and/or sold some of their equipment (Moldenhauer and Bolding 2009).

Wisconsin loggers may be better positioned to adapt to parcelization than their counterparts in the South. The most common harvesting system in much of the US South is the feller-buncher/skidder system (Baker and Greene 2008,

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Moldenhauer and Bolding 2009), which often requires five or more pieces of equipment and four or more workers per crew (Bolding et al. 2010). In contrast, the cut-to-length system is the most common system in Wisconsin (Rickenbach et al. 2005, Traver et al. 2013), and this system requires only two machines and two operators, which results in lower moving costs than feller-buncher/skidder systems. Furthermore, approximately one-third of Wisconsin loggers use chainsaw systems, and past research indicates that these loggers are more likely to harvest small private woodlands (Rickenbach and Steele 2005) and are better equipped than fully mechanized loggers to profitably harvest parcels smaller than 20 acres (Allred et al. 2011).

Wisconsin's Managed Forest Law (MFL) program was open to landowners with at least 10 contiguous acres that are 80 percent forested at the time of this writing (Wisconsin Department of Natural Resources [WDNR] 2013). The MFL program reduces tax rates for enrolled landowners from a statewide average of $42.70/acre to either $10.68/acre for land closed to the public or $2.14/acre for land open to the public. The MFL program requires landowners to have a management plan and conduct active management, including timber harvesting. The relatively small minimum acreage required for enrollment in this program may create difficulty if loggers cannot profitably harvest parcels that are 10 acres and smaller because landowners may be penalized with a noncompliance fee of $250, loss of MFL designation, as well as withdrawal taxes and fees if planned harvests are not performed.

Clearly, there is a need for logging firms that are willing and able to harvest small parcels of timber. Urbanization and parcelization will continue, and landowners enrolled in the MFL program need to have their timber harvested to comply with the law. Therefore, the purpose of this study was to identify the characteristics of and strategies used by Wisconsin logging firms that profitably harvest small parcels of timber.

Methods

Logger interviews

For the purposes of this study, a successful small-parcel logging firm was defined as a logging firm that regularly and successfully harvests parcels of timber smaller than 40 acres and is capable of successfully harvesting parcels smaller than 20 acres. The 40-acre threshold was identified as a breaking point between firms that specialize in harvesting small parcels on family forest land versus those firms that specialize in harvesting larger parcels on state, county, and industrial/corporate forestland (Rickenbach and Steele 2006).

Successful small-parcel loggers were identified by contacting 48 mills and forest industry experts by phone and e-mail. Mill contacts were targeted toward procurement foresters when these entities could be identified; however, when this was not possible, inquiries were directed to mill managers or other responsible officials. Wisconsin mills were identified using Wisconsin's Wood Using Industry Online Database (University of Wisconsin–Madison et al. 2006). Mills purchasing more than 3 million board feet of timber annually were contacted and asked to provide the name and contact information for loggers who successfully harvest small parcels of timber. The 3 million board feet cutoff was chosen to eliminate secondary mills, hobby mills, and small mills that deal with few or no loggers. These contacts yielded a total of 80 unique loggers from across Wisconsin, which represents approximately 10 to 15 percent of Wisconsin loggers based on past studies (Rickenbach and Steele 2005, Rickenbach et al. 2005, Traver et al. 2013). From the list of 80 loggers, 19 were selected for further study. Loggers were selected based on the frequency with which their firm was mentioned by mills and forest industry experts, the type of harvesting system used, and geographic distribution. Logging firms that were mentioned by multiple entities were automatically included in the study because this was considered strong evidence that the logger was actually successful on small parcels. Additionally, if a logger was said to have a unique or innovative logging system, that logger was included in the study. Finally, Wisconsin was divided into four quadrants using US Highway 51 as the east/west divider and Wisconsin State Highway 29 as the north/south divider, and at least one logger was selected from each quadrant. Forest type, population density, and topography vary considerably across Wisconsin, and therefore receiving input from loggers from each region was considered beneficial.

After the 19 loggers were selected, each logger was contacted by phone to request an on-site interview. Fifteen loggers agreed to participate in the study, while the remaining four either chose not to participate or did not return telephone calls. This participation rate is comparable to the one reported by Stone et al. (2011) in a similar study. Interviews were conducted during the summer and early fall of 2013 at active harvesting sites or another location chosen by the logger. In most cases, the interview was conducted with the owner of the logging firm, but in three cases the interview was conducted with another individual familiar with the logging firm's structure and operations, such as a staff forester or timber buyer. During the interviews, data were collected relating to the size of parcels harvested, moving costs, harvesting equipment, timber procurement, type of timber harvested, profitability, and experience.

Moving cost estimate

The direct cost of moving equipment from one site to another was provided by loggers during the interviews. For loggers that do not own a truck and low-boy, this was the cost of hiring an outside contractor with a truck and low-boy to move equipment from one site to another. For logging firms that own a truck and low-boy, this cost would include the wages paid to the truck driver, fuel costs, and wear-and-tear on the truck and low-boy. In addition to the direct cost of moving, the cost of wages for idle employees and the fixed cost of idle equipment should also be included to fully reflect the cost of moving (Cubbage 1982). The hourly cost of owning harvesting equipment was estimated using the machine rate method (Miyata 1980). The following assumptions were made for both harvesters and forwarders: an economic life of 6 years, a salvage value of 20 percent of the purchase price, an interest rate of 8 percent, a tax rate of 4 percent, and 2,000 scheduled machine hours per y (Brinker et al. 2002). Purchase prices of $300,000 and $169,000 were assumed for harvesters and forwarders, respectively (median reported investments by mechanized loggers). Equipment operator wages were estimated to be $15.31/h (US Department of Labor Bureau of Labor Statistics 2012), and labor overhead was assumed to be 40 percent of the base rate.

Harvesting cost estimate

In order to demonstrate the impact of parcel size on harvesting costs, a simulated thinning of a 50-year-old red pine (*Pinus resinosa* Ait.) stand with a site index of 60 (base age 50) was conducted. The hypothetical stand was planted with 436 trees per acre and was thinned at ages 30 and 50 as suggested by Ek et al. (2006). The harvest volume was estimated using the RPYLD version 2.0.0 growth and yield model (Hansen 2008). The harvest removed 112 trees per acre with an average diameter at breast height (dbh) of 10.5 inches, which resulted in a harvest of 47 tons/acre. Harvesting costs were estimated using LogCost version 13.1, a harvesting cost estimation model developed by the US Forest Service (Rheinberger 2013). The model includes a 2 percent profit allowance in its cost estimate; however, this was removed for the purposes of this study. Harvesting costs were estimated for a system using a John Deere 1070E harvester and a John Deere 1010E forwarder. Off-road diesel was assumed to cost $3.00/gal. Hauling costs were estimated using the values provided by Abbas et al. (2013) for a 50-mile hauling distance. Moving costs were estimated using the average direct moving cost reported by participants in the study plus the cost of idle employees and equipment as estimated using the machine rate method.

Results and Discussion

Three harvesting systems

Loggers in this study used three systems to harvest small parcels: cut-to-length (13), chainsaw and skidder (1), and specialized small-scale equipment (1). Of the 13 loggers that used cut-to-length equipment, 7 used rubber-tired harvesters and 6 used tracked harvesters (Table 1). The ability of mechanized loggers to harvest small parcels of timber is encouraging because the majority of Wisconsin loggers use mechanized systems (Traver et al. 2013). Small parcels of timber are often located near the landowner's residence, which makes timber utilization and aesthetics more important than on secluded harvests. Loggers C, F, and J suggested that cut-to-length equipment improves utilization and leaves a more aesthetically pleasing site after harvest than other systems.

One logger in southwestern Wisconsin harvested timber with a chainsaw and cable skidder. In the steep terrain of southwestern Wisconsin, it is common for loggers to construct bladed skid trails and use cable skidders to winch logs to the skid trails. Chainsaw systems typically require lower capital investments than cut-to-length systems, which reduces overhead costs and may allow chainsaw-based loggers to be competitive with mechanized loggers on small sales. This logger invested only $51,000 in equipment, whereas the smallest capital investment by fully mechanized loggers was $115,000 by Logger E (Table 1). While $51,000 appears low, the median investment by chainsaw loggers was just $60,000 in 2010 (Traver et al. 2013).

There are several disadvantages to harvesting small parcels of timber with chainsaws. First, in Wisconsin, the average chainsaw crew produced only one-third of the annual volume produced by the average cut-to-length crew in 2010 (Traver et al. 2013). In this study, the chainsaw and cable skidder system produced approximately 8,250 tons/y, while cut-to-length loggers' annual production ranged from 6,045 tons (Logger M) to 30,875 tons (Logger H). Second, worker's compensation insurance rates in Wisconsin at the time of this study were $39.78 per $100 worth of payroll for chainsaw loggers versus only $10.95 per $100 of payroll for fully mechanized loggers (Wisconsin Compensation Ratings Bureau 2013). Finally, probably because of the danger and strenuous nature of the work, it can be difficult to find employees willing to work on chainsaw crews. Several loggers in this study that had once operated chainsaw crews had shifted to cut-to-length logging in part because they had difficulty staffing chainsaw crews.

One logger used specialized small-scale equipment to harvest timber. He used a Kioti Forester DK35SE tractor, a Metavic forwarder trailer pulled and powered by the tractor, a Metavic Wheeler for transporting logs to the mill and moving equipment, and chainsaws for felling. This logger typically harvests between 500 and 800 tons per y. This system required an initial investment of approximately $128,000 for new equipment, including the cost of a pickup. While this is higher than the median investment of $60,000 by non-mechanized firms in Wisconsin (Traver et al. 2013), this system does allow the logger to perform all harvesting

Table 1.—Profile of 13 cut-to-length loggers that were identified as successful at harvesting small parcels in Wisconsin.[a]

Identifier	Harvester type	Firm structure	Firm age (y)	Annual production (tons)	Capital invested (US$)	Debt as a percentage of equipment value (%)
A	Rubber-tired	2 crews	30	29,094	649,000	35
B	Tracked	1 crew	10	23,375	525,000	90
C	Tracked	Sole proprietorship	24	7,425	193,000	0
D	Tracked	1 crew	12	18,656	610,000	52
E	Tracked	1 crew	21	14,100	115,000	50
F	Rubber-tired	Sole proprietorship	15	8,706	600,000	100
G	Rubber-tired	3+ crews	30+	18,800	500,000	80
H	Rubber-tired	3+ crews	20	30,875	500,000	60
I	Tracked	1 crew	12	19,900	410,000	<10
J	Tracked	3+ crews	43	15,438	425,000	—
K	Rubber-tired	3+ crews	20	21,825	900,000	60
L	Rubber-tired	1 crew	26	24,250	—	0
M	Rubber-tired	3+ crews	28	6,045	270,000	80

[a] For logging firms operating multiple crews, the equipment, annual production, capital investment, and debt listed are for the crew that the interviewee considered to be the best equipped to harvest small parcels of timber. A sole proprietorship includes only an owner-operator, while a crew consists of two workers.

functions from felling trees to delivering wood to the mill and moving equipment between harvest sites, whereas many loggers contract with outside entities for hauling timber and moving equipment. This logger has used this system for approximately 12 years, but has yet to make a profit. He is retired from another occupation and logging is considered an ''expensive hobby.'' He takes satisfaction in his work and considers it his contribution to good land stewardship.

While past research indicates that chainsaw loggers can be competitive on small sales (Rickenbach and Steele 2005, Allred et al. 2011), the trend toward greater mechanization in the logging industry is continuing (Traver et al. 2013). For this reason and because this study included only two chainsaw loggers, the remainder of the results will focus on participants using mechanized systems.

Capital investment

Capital investment among mechanized loggers in this study ranged from $115,000 to $900,000 (Table 1). Somewhat surprisingly, 7 of the 13 mechanized loggers had more capital invested in equipment than the median investment of $480,000 by mechanized loggers in Wisconsin (Traver et al. 2013). However, the cost of a new set of cut-to-length equipment can easily exceed $1 million, and approximately 15 percent of mechanized loggers in Wisconsin had more than $1 million invested in equipment in 2010 (Traver et al. 2013). None of the loggers in this study invested $1 million in equipment. Logger M suggested that loggers with $600,000 harvesters cannot be profitable on small parcels of timber. Only three of the mechanized loggers in this study suggested that they would be better equipped to harvest small parcels if they had additional capital invested in equipment, and two of these three simply wanted to replace one or more of their aging machines.

Several of the loggers in this study were able to reduce the purchase price of their equipment by purchasing excavators that had been retrofitted with a harvester head. Logger C purchased a John Deere 490E excavator with a Fabtek harvester head for $120,000, and Logger E purchased a Link-Belt excavator with an Upton harvester head for $80,000. These machines may be less productive than new purpose-built machines; however, for loggers harvesting small parcels of timber, accepting reduced productivity in exchange for lower fixed costs may be worthwhile.

Eight of the 13 mechanized loggers in this study had debt levels equal to at least half of the value of their equipment (Table 1). It is not uncommon for loggers to carry high debt loads because of the capital requirements of the business; however, high debt levels may reduce flexibility and force loggers to focus on tracts with large harvest volumes to ensure the firm generates enough revenue to make its monthly payments. Logger B suggested that his debt load required a break-even production level of 640 tons/wk, which made him hesitant to commit to harvest small parcels.

Timber harvest size

Participating loggers estimated that their average harvest size during the previous year was just 27 acres, which is approximately the same size as the average family forest in Wisconsin (26 acres; Perry et al. 2012). Despite the impacts of parcelization and the recent economic downturn, 7 of the 13 mechanized loggers reported that they were profitable in each of the past 10 years, and 11 of 13 had been profitable in at least 7 of the past 10 years. Six of the 13 mechanized loggers reported an average harvest size smaller than the average family forest (Table 2). Twelve of the 13 mechanized loggers harvested tracts that were 10 acres or smaller during the previous year. Eleven of the 13 stated that they would be willing to harvest parcels as small as 5 acres as long as the tract required only a short move (<5 mi). In terms of volume, 8 of the 13 loggers in this study stated that they would be willing to harvest parcels with as little as 150 tons of timber (about five truckloads). These results are similar to those of Kittredge et al. (1996), who found that more than 80 percent of Massachusetts loggers would harvest a 5-acre parcel if it contained five truckloads of timber and/or was no more than 5 miles from home.

These results indicate that properly equipped loggers are capable of harvesting MFL mandated harvests. The majority of participants in this study were willing to harvest parcels that are 10 acres or smaller, which is the minimum acreage required to enroll in the MFL program (WDNR 2013). Logger K suggested that during the early days of the MFL program, plan writers had a tendency to lay out harvests that

Table 2.—Average harvest tract size during the previous year, the smallest harvest performed during the previous year, and the smallest parcel that the logger would be willing to harvest as estimated by participating mechanized loggers.

	2012 harvest size (acres)		Avg. moving distance		<5-mi moving distance	
Identifier	Avg.	Smallest	Minimum required harvest size (acres)	Minimum required harvest vol (tons)	Minimum required harvest size (acres)	Minimum required harvest vol (tons)
A	30	1	0.5	10	0.5	10
B	40	5	10	234	5	234
C	20	10	20	186	3	74
D	18	10	5	124	5	124
E	50	5	10	235	4	118
F	30	20	15	299	2	62
G	20	<1	10	235	5	59
H	30	3	1	119	1	119
I	40	5	20	746	5	373
J	20	3	10	238	10	238
K	28	1.5	10	364	5	243
L	20	3	10	243	10	243
M	10	3	3	116	2	70

were as small as 2 or 3 acres, meaning that the planner had taken a 10-acre parcel and applied several different harvest prescriptions that required separate stand entries. Logger K suggested that progress had been made and that most MFL plans had feasible harvest prescriptions today. Logger L echoed these sentiments, stating that the MFL program is ''wonderful'' for both landowners and loggers and that foresters are doing a better job of planning manageable harvests than in the past.

It is important to recognize that the number of acres available in a timber sale is not the only factor that influences feasibility. When asked to rank the importance of harvest area, harvest volume, timber value, and the proximity of a site to current or planned harvests, loggers ranked volume as most important, followed by value, proximity to current or planned harvests, and then harvest area. Furthermore, site-specific characteristics such as access, operability, and proximity to the mill were listed as factors that influenced loggers' decisions to harvest small parcels. Easy access for trucks and good landing locations reduce logging costs. In Wisconsin, many parcels are inaccessible during the summer months because of soil moisture, oak wilt concerns, or other restrictions, and so small parcels that are operable during the summer are attractive to loggers. Sites that are close to a mill have low transportation costs, which may offset high harvesting costs on small parcels. Nevertheless, parcel size is important in determining operational feasibility, because volume and value available on a site at rotation age is determined in part by early-rotation and midrotation thinnings, whose feasibility is dependent on acreage because these treatments generally produce low per-acre volumes.

Timber purchasing strategies

Ten of the 13 mechanized loggers interviewed during this study purchased at least 50 percent of the timber that they harvest, and 9 of these loggers purchased at least 80 percent of the timber that they harvest (Table 3). Loggers have historically been the primary purchasers of stumpage in Wisconsin (Rickenbach et al. 2005). This strategy gives loggers flexibility in terms of the tracts that they harvest and allows them to group small tracts together to reduce moving costs.

Table 3.—Timber purchasing strategies employed by 13 mechanized small-parcel loggers in Wisconsin.

Strategy	No. of loggers using strategy ($n = 13$)
Primary purchaser of timber (≥50% of timber harvested)[a]	
Logging firm	10
Mill	2
Third-party wood broker	2
Most common harvest type	
Thinning	7
Regeneration harvest (clear-cut, seed tree, or shelter wood)	3
Equal	3
Services in addition to logging	
Food plot establishment	7
Land conversion	4
Wildlife openings	2
Brush removal	2
Yard-tree removal	2
Other	5
None	2

[a] Does not sum to sample size because one logger harvested equal amounts from two categories.

Every mechanized logger in this study has attempted to group small sales together. Most of the loggers had been somewhat successful with this approach; however, grouping sales does not overcome all of the challenges associated with harvesting small parcels. For example, for loggers owning tracked equipment, any move beyond crossing a road will require a truck and low-boy, which will cost the logger several hundred dollars. Second, each harvest requires paperwork to be filed with the county in which timber is to be harvested. Third, each harvest, regardless of the volume available, requires time to be spent with the landowner prior to the harvest to ensure the landowner's objectives are achieved. Harvest preparation costs are especially important for logging business owners that also operate equipment. Four of the loggers in this study had a business owner that was responsible for purchasing timber and operating equipment. These loggers must target parcels that yield enough volume to compensate for the production lost while meeting with landowners. Logger L refuses to harvest parcels with less than 360 tons available for harvest because on parcels with less volume, he will lose money because of time spent with the landowner. Three of the logging firms in this study employed foresters to purchase timber and interact with landowners; however, the remainder only hired foresters to perform specific tasks such as timber marking and plan writing, meaning that the logger was the primary contact with the landowner for the majority of the firms in this study.

Loggers often perform services in addition to timber harvesting to appeal to landowners. All but two of the mechanized loggers in this study offered at least one service other than timber harvesting, with food plot establishment the most common service provided (Table 3). For most loggers these additional services were not a large part of their business, and they did not perform these services on every sale, but these services did help them purchase timber from some landowners. Loggers should ensure that they are compensated for the time spent performing these services either as a direct payment or in the form of reduced stumpage rates. The cost of owning and operating cut-to-length equipment can easily exceed $100 per scheduled machine hour per machine (Adebayo et al. 2007), and so loggers cannot afford to conduct these services for free. Logger K stated that he often engages in a ''bartering process'' with landowners over special services to ensure that he makes money and the landowner's objectives are achieved. Logger L stated that he tries to limit the time spent on additional services because landowners expect this work to be conducted free of charge.

Moving distance and cost

The average moving distance for mechanized loggers in this study was just 30 miles. The average reported moving cost was also fairly modest at $406 per move for cut-to-length systems. However, once the costs of idle equipment and the wages paid to idle employees are included, the average moving cost increases to $778 per move. By

*Table 4.—Logging costs for a hypothetical thinning of a 50-year-old red pine stand (*Pinus resinosa *Ait.) with a cut-to-length harvesting system illustrating the impact of harvest size on delivered cost.*

Harvest size (acres)	Harvest vol (tons)	Cost ($/ton)			
		Harvesting	Moving	Hauling	Delivered
40	1,897	24.61	0.41	8.08	33.10
10	474	23.97	1.64	8.08	33.69
5	237	23.79	3.28	8.08	35.15
1	47	23.54	16.41	8.08	48.03

comparison, Greene et al. (1997) assumed moving costs of approximately $1,500 (adjusted to 2014 dollars) for cut-to-length and whole-tree systems, and Abbas et al. (2013) calculated moving costs well in excess of $1,000 per move for cut-to-length systems. It is important to note that if loggers moved outside of normal operating hours they could reduce their moving costs to approximately $406 because the costs of idle equipment and idle employees would not apply. However, the vast majority of loggers in this study moved during normal operating hours. Several loggers reduced their moving costs by driving rubber-tired equipment on public highways between sales. This strategy allows the logger to move at his convenience and allows the harvester and forwarder to move between sites at different times. For these reasons, Logger H stated that he was willing to drive his equipment on public roads for up to 10 miles between harvest sites.

On average, cut-to-length loggers required a minimum volume of 242 tons to justify moving a typical distance to a new harvest site (Table 2). Assuming a move costs a total of $778 and the harvest generates 242 tons of timber, the logger would incur moving costs of $3.21/ton. Assuming that mills are not willing to pay extra for timber harvested from small parcels, this cost must be recovered from reduced stumpage prices.

Simulated harvest

In order to demonstrate the impact of reduced parcel size on harvesting costs, a simulated thinning of a 50-year-old red pine stand was conducted. The harvest generated approximately 47 tons/acre (Table 4). Seven of the 13 mechanized loggers in this study harvested at least one-quarter of their annual volume from red pine stands, and 10 of the loggers stated that they harvested at least as much volume from thinnings as regeneration harvests (Table 3). Therefore, this simulated harvest can be considered representative of what the loggers in this study harvest.

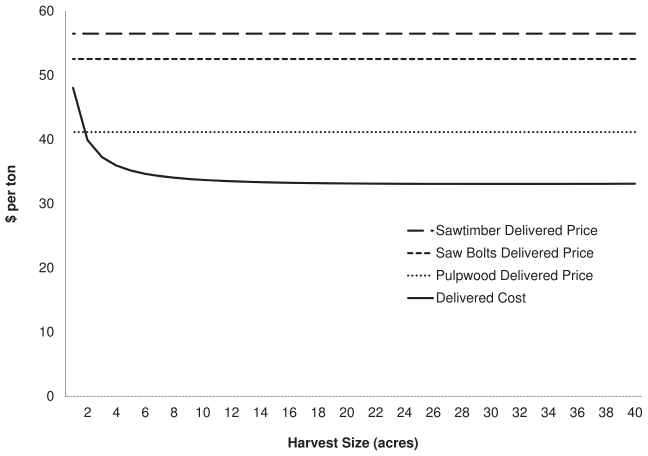

*Figure 1.—Delivered cost and delivered prices (Prentiss and Carlisle 2012) for a hypothetical thinning of a red pine (*Pinus resinosa *Ait.) stand that removes 47 tons/acre assuming hauling costs of $8.08/ton and one-way moving costs of $778.*

On a 40-acre parcel, the delivered cost of timber was $33.10/ton (Table 4). This is lower than the costs reported for cut-to-length systems in Michigan (Abbas et al. 2013), but is similar costs reported for cut-to-length systems in Georgia after adjusting for inflation (Greene et al. 1997). With a parcel size of 40 acres, the logger could break even if he paid stumpage prices of approximately $8, $19, and $23 for pulpwood, saw bolts, and sawtimber, respectively, at recent delivered prices (Prentiss and Carlisle 2012). As parcel size is reduced, moving costs per ton increase, which necessitates lower stumpage prices if the logger is to remain profitable. In this scenario, the delivered cost of timber does not exceed the delivered price of pulpwood until parcel size reaches 1 acre (Fig. 1). It is important to note that sale preparation and administration costs are not included in this simulation because these costs will vary considerably between sites, between organizations, and may be paid for by the landowner directly.

Clearly, small landowners should not expect to receive the same stumpage prices per unit on a 5-acre parcel as they would receive on a 40-acre parcel. On the other hand, loggers should be cognizant of paying competitive stumpage rates. When purchasing timber from small landowners, the power of reputation and word-of-mouth is significant. If a logger earned a reputation for paying below market rates for stumpage, the logger might find it difficult to purchase timber from landowners in the future. Logger A noted that 30 years of experience and a good reputation allowed him to purchase timber from small landowners and also remain profitable in each of the past 10 years. Logger C noted that he had several years' worth of timber lined up to harvest because landowners request him to harvest their timber because of his stellar reputation.

Conclusions

Mechanized loggers in this study are currently harvesting parcels that are 10 acres and smaller, and these loggers are willing to harvest parcels with as few as five truckloads of timber available. This is encouraging because of increasing mechanization in the logging industry and the ongoing parcelization of family forestland. All participants in this study were willing to harvest 10-acre parcels, which is the minimum parcel size that can be enrolled in the MFL program (WDNR 2013). This is important because enrolled landowners can face taxes, fees, and loss of MFL designation if planned harvests are not conducted. Loggers

in this study were generally pleased with the MFL program, and they suggested that progress had been made in ensuring that planned harvests are operationally feasible.

Loggers in this study used a variety of strategies to remain profitable. First, loggers attempted to keep fixed costs down. Many loggers in this study operated somewhat old equipment, and while it is likely that this equipment is less productive than new equipment, for loggers harvesting small parcels, accepting lower productivity in exchange for reduced fixed costs may be a worthwhile trade. Mechanized loggers in this study reported direct moving costs of just $406 per move and $778 when the costs of idle equipment and employees are included, which is lower than previously published estimates (Greene et al. 1997, Abbas et al. 2013). Second, most loggers in this study purchased their own stumpage, which allows them flexibility in the parcels that they choose to harvest and allows them to use strategies such as grouping small sales together and performing customized services such as establishing food plots in exchange for reduced stumpage rates. Third, loggers in this study were able to successfully manage their business relationships. Each logger in this study reported a positive relationship with local mills, and many suggested that their longevity in the business and strong reputation allowed them to purchase timber from family forest landowners at prices that were agreeable to both parties.

Finally, it is important to recognize that when deciding whether to harvest a particular parcel, timber volume and harvest logistics are generally more important to loggers than the number of acres available. However, in terms of policy and long-term wood supply, parcel size matters. Parcel size is used to determine eligibility for programs such as the MFL, and property taxes on forestland are generally levied based on the number of acres owned. Finally, the volume and quality of timber available at rotation age is dependent in part on early-rotation and midrotation silvicultural treatments, which may not be economically feasible on small parcels because of the low per-acre volumes produced. Therefore, it is important that loggers continue to adapt to reduced parcel size to ensure the continued competitiveness of Wisconsin's wood supply chain.

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