

METHODOLOGIES FOR SETTING TIMBER HARVESTING RATES

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Abstract: *Timber harvesting has always been a major business cost component for forest owners and or forest management companies. One major development in improving harvesting efficiency was the recognition that using independent contractors captured both the innovation skills as well as the motivation to improve productive effectiveness for those managing operations. Since the 1960's most developed countries extensively use a contractual based harvesting workforce.*

What combines the forest manager and the harvesting contractor financially, through a contract, is the logging rate. In an idealized open market system the logging rate would be determined by supply and demand of services. However, a true open market system is rarely used to set harvesting rates. This paper discusses what constitutes a harvesting rate and reviews three different methodologies that can be used to develop them. Information was captured through interviews with company representatives in the USA and New Zealand, as well as reviewing relevant literature.

1. Introduction

Timber harvesting costs have always been a major business cost component for forest owners and or forest management companies (Loving, 1991). Maintaining a cost-effective harvesting workforce is a major task for many forestry companies, and, operating a financially successful harvesting contracting business is a major challenge (Mooney, 2001). With increased global competition for wood based products there has been real pressure on reducing the harvesting rate (cost of harvesting on a per unit basis).

The capital and operating cost of logging systems increased dramatically with the mechanization of operations. Harvesting evolved from manual labor with basic tools and low production to high capital cost with low labor input and high production systems (Conway, 1985). The need to carefully manage the cost of owning and operating equipment has long been recognized (Mathews, 1942). In modern operations labor may amount to only about 30% of the total operating cost and the effective utilization of the high cost equipment becomes paramount (Stuart, 2003).

Technological advances in equipment and systems, as well as optimization of established logging systems over time have resulted in incremental improvements in logging efficiency. However, there have been real cost increases in many of the base components for logging operations (E.g. Stuart et al. (2003) reports a 22% increase from 1995 to 2003 in the Southern US). In recent years, fuel cost has been an obvious increase, but there have also been 'real increases' (over and above inflation) in labor, materials as well as insurance.

One major 'step-change' in the management of the harvesting workforce was the shift from company based crews to contract crews. Using independent contractors captured both the innovation skills as well

as the motivation to improve productive effectiveness for those managing operations. Since the 1980's most developed countries extensively use a contractual based logging workforce.

Using contract logging crews, forestry companies do not have to absorb the capital cost of logging equipment and can simplify their management operations. It also allows them to resize operations where the logging workforce can be reduced by simply offering fewer contracts. However, in most cases companies do not want to reduce the overall workforce capacity and have a tendency to use mill quotas to limit production of their contract loggers. Greene, et al. (2004) showed that mill quotas have increased unused capacity, which in turn drives up harvesting cost.

Some companies and or federal state forest entities tried to capture some of this innovation and motivational aspect without going to a logging contractor system (many were restricted by unions). They implemented a performance based incentive plan that promotes employee efficiency. Within these systems, based on stand and site variables, productivity expectations are established with opportunities for individuals to earn a bonus based on achieving a higher than expected production. Different incentive systems have been developed and compared (e.g. Rehschuh, 1965). The problems associated these systems are that production expectations are based on time and motion studies; so the production expectations are merely based on the existing systems.

Forest operations researchers have long identified the importance of understanding the impact of changing stand and terrain parameters and productivity, and hence cost effectiveness of harvesting. Recent trends in silvicultural regimes include has reduced rotation length as well as lower harvest intensity. Both of these factors have a negative impact on productivity and hence profitability (Kluender and Stokes, 1999). Logging contractor have attempted to improve productivity and control costs when harvesting smaller logs (Conway, 1997), often with little success. Using intensive studies and long term data capture for a given operation allows for using economic analyses tools, such as marginal costs analyses, to determine marginal tree size, most profitable crew size, whether to operate or shut down (Bruce and Adams, 1962). However a truly comprehensive understanding of how changing terrain and stand parameters affect a range of logging systems has not been achieved.

Despite this inability to fully understand all logging scenarios, there is often a need for developing realistic costing models for long term forest management planning. Time and motion studies can be used to develop an understanding of how individual machines that make up the harvesting system respond to stand and terrain parameters (Visser and Stampfer 2003). They can then be combined to provide indicative system response. For example Hartsough et al.(2001) developed a costing model for harvesting small trees in natural stands that include four gentle terrain harvesting systems, as well as two steep terrain harvesting systems. It can be expected to yield accurate information for operations in similar conditions. Attempts have also been made in combining published productivity functions to build a more robust logging system costing model (e.g. McDonagh et al. 2002). Although such models appear to provide reasonable estimates for changing parameter values, they rely on initial accurate production and costing information to 'prime' the model.

One opportunity to improve our understanding of cost structures is by analyzing actual information from logging contractors (Loving 1991). For example Stuart et al. (2003) showed that on average for 44 logging contractors studied extensively in the US was 16% on equipment, 20% on consumables, 32% on labor, 3% on insurance, 26% on contractor services (i.e. repairs), and 3% on overhead costs. If such data is captured over an extended period of time 'Cost Indices' can be developed to help manage logging rates. Companies have also tried to establish 'logging rate calculators' that use a series of base rates and indices to adjust logging rates over time – mainly for adjusting for changes in fuel prices. The GP rate calculated developed by Watson (2002) recognized that there are a certain number of factors beyond typical stand and terrain parameters that caused a necessary adjustment in logging rates. They referred to these as 'add-on' and included elements such as 'excessive Best Management Practices', 'excessive haul

on secondary roads' and 'cut-to-product'. Both upstream (harvest planning) and downstream operations (trucking strategy) can significantly impact harvesting operation efficiency (Loving 1991)

Under relatively stable work environment the industry at large starts to build a certain level of status quo: harvesting rates are developed over an extended period of time as neither the harvest systems nor the stands to be harvest change much. In such a scenario companies rely on previous experience to set logging rates (Shaffer 1986), and adjustments made based on real cost increases.

However a changing business environment means that such a stable environment rarely exists. One example is that many major long-term dedicated forest companies are 'transforming' themselves, or divesting to, timber land investment companies. The new forest owners' focus in general has shifted from true 'forest management' to 'asset management'. Operating costs, such as logging, becomes secondary to increasing the overall value of the asset.

Although there are many factors and issues surrounding the costing and productive effectiveness of logging systems, perhaps the main real issue is the question of what methodology should be used to establish a harvesting rate. This appears to be a major issue for many companies and logging contractors as they establish new working relationships. The question is often formulated as such; "what is a fair logging rate?". From the company perspective, they do not wish to pay an excessively high rate for harvesting services. For contractors, they need to be able to establish effectively a series of rates that determines what a cost-recovery rate is to establish if they should work at all, as well as work out what a profitable rate is to sustain a successful business.

Defining the Logging Rate

In its simplest form, the logging rate is a payment for services, whereby the service provided by the contract logger to the forest company is the conversion of standing trees into a series of specific log products. The logging rate is most commonly expressed in terms of the scaling system used by the mills. If the product is weighed then a rate is typically \$/ton, if the product is scanned or measured in some way then the rate will be in \$/unit volume (e.g. m³ or ft³). A greater level of uncertainty is introduced if the logs are scaled on their expected output from a mill – for example Board Feet in the USA. In such a scenario, there tends to be an additional negative bias towards smaller logs, as well as trees with greater taper.

Compliance with meeting specific log specification is however not the only criteria set out in a contract. Common additional requirements include meeting safety and environmental standards.

So the service the company is paying for is: ***Harvesting Rate = log products + safety standard + environmental standard***

While compliance with safety standards in most cases tends to be a straight forward assessment, environmental compliance is more of a moving target for most companies and contractors. Not only are environmental regulations and best management practices updates on a regular basis, interpretation and implementation can also vary by person and by site (Yonce and Visser, 2004). This means adherence to an environmental compliance component of the contract is often ambiguous. While few logging rates are ever adjusted for excellence in environmental performance, it leads to a certain level of categorization by companies and in turn provides some unwritten preference to harvest contractors who are perceived to comply more rigorously.

Establishing the Logging Rate

The logging rate can be broken down into its two basic components: Whereby the logging rate is the quotient of the harvest system cost divided by the harvest system productivity for a given time frame (for example, per Scheduled System Hour).

$$\text{Logging Rate} = \frac{\text{System Cost (\$/SSH)}}{\text{System Productivity (m3/SSH)}}$$

Through the interviews conducted (18 different company and contractor representatives), most organization use a combination of strategies to determine (or manage) harvesting rates. For the purpose of simplification as well as respecting sensitive nature of specific company details, the concepts are grouped into three methodologies: (1) the free market, (2) the predictive model and finally (3) the retrospective model.

Free market methodology

In a *free market* (capitalistic) system that optimizes the effectiveness of using independent logging contractors the simple supply and demand principle is used to set harvesting rates. The dual benefit being the companies get the lowest possible cost logging services, and the most cost effective loggers making the largest profits. In such a system the forest company would use a *competitive bidding process* for a logging service contract (specifying all the required standards). Only the harvesting contractor need concern him/herself with determining a competitive logging rate (they would use one of the following methods to establish a competitive rate). This seems ideal in that the harvesting contractor should know most accurately what their systems cost and productivity are.

In a free market system the agreed rate for services is, in fact, the fair rate.

There seems to be two main problems why companies shy away from a true free market system, and one problem for contractors. The first is that forestry rarely operates in a true open market system. The restricted market condition is caused by geographical limitation and the complexity of harvesting systems. The second more critical factor is artificially imposed, and best described as 'company control'.

Forest land holdings tend to be quite regional in nature, and most harvesting contractors also work in a preferred 'home base' region. There is quite a considerable transportation and relocation cost associated with trying to compete with a existing harvesting crews in another region. In many cases there are just a few contractors that can provide a given service. The knowledge and skill required, as well as the initial capital required means that often there are very few people who can enter the market as new logging contractors.

Technically a free market system would still function, just the marginal cost to the company for encouraging competition is exceptionally high. If the local contractors are bidding high, then a contractor from another region could relocate or purchase the required equipment to provide that service.

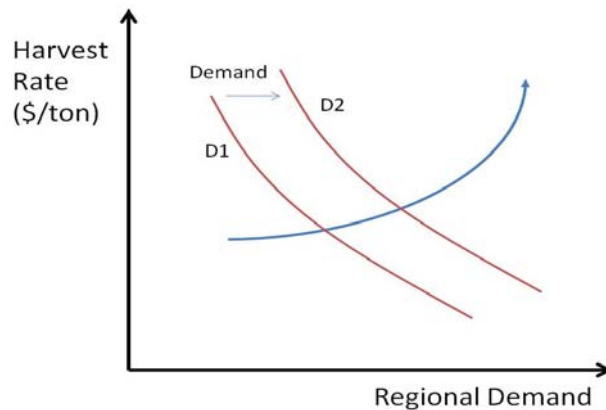


Figure 1: Supply and demand curve showing that increase in regional demand for harvesting services increases the harvest rate – indicating a constrained market

‘Company Control’ is an artificial factor. In reality, most companies don’t just want the harvesting service (as per contract) – but they wish to retain a greater level of control over the logging process. For example, most wish to retain the right to ask a logger to stop producing when the mill yard is full, retain the right to ask a logger to move when a different log type is in demand. They may also ask their contractors to purchase additional equipment, or change their equipment mix depending on their perceived optimization strategy or future needs. In many cases, loggers need to maintain cash flow and make debt payments which leave them at the mercy of company requests.

For the contractor, their main problem is associated with not being able to accurately predict the impact of a new setting (stand and terrain factors) on their cost, and hence struggle to accurately determine their own competitive (but profitable) harvesting rate.

Therefore in most cases the forest company attempts to play an active role in establishing harvesting rates. In this case a free market system will not work and there is the need to use an interactive logging rate setting methodology.

Retrospective Costing System Methodology

Retrospective costing uses a combination of ‘*cash flow analyses*’ to determine logging system cost as well as *recent productivity records* to determine production. This is the perhaps the most accurate method, but only if the system and conditions do not change.

Cash flow analyses is simply predicting future costs based on recent costs. It requires going ‘through the books’ (cost records) of a contractor to assess the actual cost of operating the system. Problems can occur with adequately spreading the ‘big-item’ costs, such as major repairs, as well as correctly accounting for machine depreciation. Establishing production retrospectively is also quite simple, both contractors and companies have access to the weighbridge tickets.

There are a number of limitations to using this type of methodology. It is very limited when attempting to assess the impact of changing operating conditions, not just stand and terrain but also operating hours, distance from home etc. The second is that a company should never be allowed to review the books of their independent contractors (violations of anti-trust regulations), but if the contractor does cooperate; the company has to have faith the costing numbers being presented are in fact accurate. A logger who is paid primarily on the basis of his actual costs will behave much like a company logging crew, as opposed to an independent contractor.

It is possible to develop quite an advanced rate setting methodology based on this approach using an Envelopment Analyses approach (LeBel 1996). By capturing a larger range of harvesting rate data for a range of harvesting systems, it is possible to establish the lowest harvest rate based on stand and terrain parameters. This would allow a company to develop 'harvest rates curves' that reflect the lowest cost harvesting system for that site – and pay according to that scale. Cost of inefficiency (non-optimal system for the site) would then be met by the contractor.

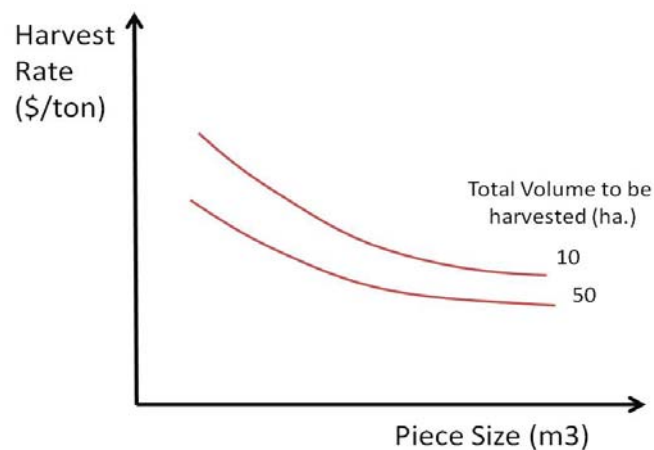


Figure 2: A Harvest rate curve developed using just two parameters; average piece size and total harvest area. As both piece size and harvest area increase the expected 'lowest cost' harvest rate declines

Predictive 'Model' Methodology

Predictive 'Model' systems use either *spreadsheets* or simple programs to establish 'fair' harvest rates. The spreadsheet systematically sums up all the labor, machine, supplies and operating costs to give us the overall system cost. Spreadsheets allow for changing, and or analyzing, the impact of new costs such as adding new equipment, increases in supplies and materials. Such spreadsheets are well developed and understood; they are used by a majority of companies and loggers to some degree. The main problem with the spreadsheet approach is taking into account all of the small costs, as well as agreeing on fundamental costing issues such as whether or not to include risk and profit in a 'fair rate'.

Predicting productivity, which is hard enough for a single machine, is especially difficult for a whole system. Through research and/or good long term data collection it is possible to establish the effect of changing stand and terrain parameters on a harvesting system. If it is possible to establish trends then they can be included into the spreadsheet (e.g. Auburn Harvest Analyzer¹). The 'fair rate' is then the resulting output from the spreadsheet.

Although the predictive model approach is the most robust in a changing work environment, and it allows companies and harvest contractors to work 'together', it tends to be less accurate than the retrospective approach.

¹ See <http://www.cnr.vt.edu/harvestingsystems/Costing.htm>

2. Conclusion

Harvesting is one of the main costs of actively managing a forest. Determining an appropriate logging rate is quite complex and this paper has presented a number of issues. The paper also attempted to group the harvest rate setting methodologies into three groups; free market, retrospective and predictive. Each method has advantages and disadvantages and they are discussed. One key aspect to keep in mind when developing it that the harvesting workforce is contractor based, and the harvesting rate methodology used needs to capture the innovation and motivation of the contractors. Ineffective rate setting methodology serves neither the company needs for a competitive harvest rate, nor the contractors need for a profitable harvest rate.

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