# CUT-AND-SKID BUSINESS PLAN FOR THE OTTAWA VALLEY

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Major Advisor Second Reader

# A CAUTION TO THE READER

This HBScF thesis has been through a semi-formal process of review and comment by at least two faculty members. It is made available for loan by the Faculty of Natural Resources Management for the purpose of advancing the practice of professional and scientific forestry.

The reader should be aware that opinions and conclusions expressed in this document are those of the student and do not necessarily reflect the opinions of the thesis supervisor, the faculty, or Lakehead University.

# ABSTRACT

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Key Words: Cable Skidder, chainsaw, cut-and-skid, feasibility, John Deere, Ottawa Valley, Ontario, Quebec, revenue model, Timberjack, time study,

The purpose of this thesis is to perform a feasibility analysis for starting a cut and skid harvesting operation in the Ottawa Valley. This is done using time studies and harvesting costing. It is proposed that a cut-and-skid operation can feasibly function in the Ottawa Valley with proper management and planning. The modelling tool built predicts net revenue by looking at cable skidder and chainsaw production values, hauling and machine costs, as well as mill revenues. By use of the models built in this study, it is proven that a conventional cut-and-skid crew can operate profitably in the Ottawa Valley.

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# INTRODUCTION

The Ottawa Valley has a forest industry that has been largely supported on the extraction of hardwoods as well as white pine. The careful logging required in selection cuts for hardwoods is generally well managed using the cut-and-skid system. With the advancements of forest mechanization, motor-manual logging is being pushed out of the local industry. In the Ottawa Valley, there is still an important place for cut-and-skid logging due to the tree species of the area and the unique terrain. An aerial image of the Ottawa Valley is found in Appendix II.

As mechanized logging, such as cut-to-length harvesting, is increasing in the area, there are still companies that focus on the relatively older cut-and-skid system. These companies, however, are older and are less intensive in their management styles. There is room for much improvement in the current forest industry of western Quebec and Eastern Ontario considering small logging businesses. Many areas can be improved notably relative to overall efficiency and production.

The objective of this thesis is to create a plan and methodology for a business to prosper in the Ottawa Valley using primarily the cut-and-skid system of harvesting. It will be analyzed primarily looking at the forests of Eastern Ontario and Western Quebec; the forests of the Ottawa Valley. These include the Ottawa Valley Forest and Algonquin Park in Ontario, as well as Pontiac County, ZEC St. Patrice and ZEC Dumoine in Quebec. The utilization of wood and fiber extraction will be analyzed. As there is a relatively large number of local sawmills (hardwood and softwood) in the area, wood prices and the associating harvest costs will be analyzed in accordance with hauling costs to utilize the most efficient recovery of the products. The revenue of a small-scale logging operation in the area could be analyzed and then consequently maximized with the techniques outlined in this thesis. This is done through the development of costing and revenue models which will ultimately determine the feasibility of implementing a cut-and-skid harvesting operation in the Ottawa Valley.

The forested area of the Ottawa Valley is unique with it's hardwoods, white pine and steep varying terrain in combination with flat terrain. The use of cable skidders and felling by hand can expand the range of harvesting operations to terrains that are very rocky and unsuitable for feller bunchers and grapple skidders. This type of terrain is very prominent, especially on the Quebec side of the Valley, and can be damaging to feller bunchers. Also, cable skidders can perform in more sensitive areas than feller bunchers and grapple skidders thus give more options for wood extraction.

With much of the competition in the area being smaller businesses, there is no major monopoly on the harvesting of the forests that can hinder the growth of an initially small new business. As there is no single major harvesting monopoly, there are a large number of family owned businesses within the region.

It is also important to note that there is a lack of a tree cutting by-law in the Renfrew and Pontiac County's, meaning there is no need for tree marking on private land. This is unique to the area as most other areas with similar forest types have more intensive tree cutting by-laws and require marking on private land. As there is quite a bit of private land in the area, there has been much high-grading. This can bring forth to the importance of careful logging that would be implemented by the use of cable skidding and felling with chainsaws, thus making a company using this system more desirable for contractors and sustainable forest license (SFL) holders.

# LITERATURE REVIEW

## Business Planning

When creating a business plan, a clear well formulated vision is essential for a favorable outcome. It is important to include the four pillars of a sustainable business: leadership, staffing, information technology and compensation (Sachdev 2014). The business plan will generally include market analysis' and how the goals and offerings of the business can be included in the specified and desired market. Outlined will be the methods of management to reach the determined objectives based on the financial considerations and constraints set in place by the company. Business plans also indicate the manner and source of which funding will be coming from. At times, investors will be able to use the business plan to determine the potential profitability of the business based on the financial and market analysis (Dziak 2017).

The globalization is creating a competitive market in forest products by lowering costs of production to maximize overall returns. Intensive management of a business model can help compete within this over-competitive market. The paper by Kajanus *et al.* (2014) explains the design process of the business model must be effective. Within the process business model, the participants, objectives, and all other criteria should be well identified. The models for the business are also only suitable when assessing within the context of the business itself (Kajunas *et al.* 2014). In a cut-and-skid business plan, a model is to be determined based on the context of the unique characteristics of the area and the determined or desired output of the business.

Ottawa Valley Forestry

Forestry is still quite prominent in the Ottawa Valley. It has been a very important factor in the economic development of the area throughout history. Many of the surrounding towns like Mattawa and Whitney for example, still rely on logging in Algonquin Park. Algonquin has a very rich history of logging; notably the square timber trade (Reynolds 2010). Many people and groups are still against logging in Algonquin Park though its economic as well as environmental benefits have proven to be beneficial and sustainable.

There is a large number of operating sawmills and pulp mills in the area. These include, but are not limited to, Hokum, Heidemen, Jovalco, Fortress, Shaws, and many more. These mills are mainly dependent on resources extracted from the Ottawa Valley Forest and Algonquin Park. A map of these mills and their proximity to Pembroke, Ontario and Algonquin park is found in Appendix I. With many construction companies in the area as well as a fiberboard plant, the products from these mills are in high demand. Figure 1 shows the area of the Ottawa Valley.


Figure 1. Area of study: The Ottawa Valley, with Pembroke, Ontario as the centre point (Source: Google Maps).

Cable Skidding

The tree length method is most commonly used when using harvesting with a chainsaw and cable skidder. The chainsaw operator fells the tree, delimbs and tops it for the skidder that brings it to the landing. The cut-to-length harvest method is where trees are felled, delimbed and then bucked to the desired lengths at the source of the tree. The trees are then transported to the landing. This method can be used in cut and skid logging as well, though it is not as common in the area (Pulkki n.d.). In the Ottawa Valley, tree length is most commonly used as the bucking occurs at the landing.

A study done by Klymanek and Synek (2015) examined the parameters of different skidding technologies and their weights on general environmental impacts. By determining the characteristics of different types of areas, the weights of the parameters can be applied to the different types of skidding techniques. Area-based input parameters were used and include things such as terrain, soil characteristics, stand information, and technological capabilities of the certain skidding methods. Skidding methods can very dependent on different areas of concern, as well as there are many different ways in which wood can be extracted. The methods of wood extraction considered in this study were farm tractor, cable skidder, cable yarder, forwarder, and forwarder with a harvester. Terrain was assessed for different areas within the large test zone. Terrain was classified with slope, general terrain, soil strength and presence of obstacles. With these parameters, viability of the use of certain methods can be determined in conjunction with the different skidding systems.

The mitigation of ground disturbance can be important when working in areas of high sensitivity. By using a cut-and-skid system, lighter environmental impacts are generally quite possible. Having lighter impacts on the environment creates a broader range of potential areas of work. The study by shows that the excessive traffic of forestry equipment can create extreme rutting on skid trails. As there are numerous passes on skid trails with cable skidding, leaving excess slash on skid trails can significantly help mitigate the effects of rutting and erosion. Road maintenance costs can be eased in this case (Agherkaklia *et al.* 2014).

The productivity analysis of cable skidding is different from that of a grapple skidder. This is mainly due to the difference in tree species skidded as well as terrain factors. The time consumption of cable skidding should be evaluated in itself. The productivity can be divided into the winching or hitching, positioning, time unloaded, skidding, and unhitching and piling at the landing. This can be dependent on maximum skidding distance, log sizes and species, winching distance and skid trail spacing. There also can be factors such as the model of the skidder or the capabilities of the operator (Borz *et al.* 2013).

The feasibility of forest products is based on the market prices relative to the harvesting costs. There is also profit to be made with the extraction of biomass in the form of slash. With different harvesting methods and systems, and dependant factors, biomass can be more favorably utilized to turn a profit (Botard *et al.* 2015). The high number of hardwoods can result in valuable fiber for biomass extraction. However, with the more commonly used method of tree length harvest with cable skidders, biomass extraction may be difficult.

The "piece-volume-law" can be used to determine the productivity of the skidders directly. This is in relation the different sizes of the timber being felled. The larger the trees will result in lesser piece extraction but a higher volume extraction. Slope in conjunction with volume or piece size can greatly affect productivity. It does not only affect it through time spans but through the energetic inputs because of the larger volumes and slopes that called for more fuel consumption. The extra power requirements can lower the overall productivity of skidders if the wood being extracted is not of high enough value. As there are many different types of cable skidders, this can be analysed to determine the best type relative to the piece-volume-law. For example, with a larger skidder, the energy input may be affected less with larger volumes of wood because of a larger skidding capacity (Vusic, 2013).

# MATERIALS AND METHODS

Market research is done by retrieving and assessing wood prices for the area. The wood prices retrieved are for all the available mills in the Ottawa Valley, with a few exceptions. The price list comes from the Pontiac Forest Products Producers Board (PFPPB). This list has the specifications, accepted species and prices for a large number of local sawmills and pulpmills. These prices will give a basis on potential revenues that can be obtained in desired harvest operations. A wide range of options will be explored considering wood buying. Through economic analyses, the most profitable mills and wood buying contractors will be indicated. Economic feasibility is determined in order to decide if harvesting operations with the mill price can be combined in a profitable manner. To determine economic feasibility, production and costs will be analyzed with potential revenue in a cost analysis.

With the use of productivity averages, harvesting operation scenarios can be hypothesized and outcomes can be predicted. The mill prices can then be used to determine the overall revenue.

In 2012, a study on Long Skidding was done by Shaun Dombroskie, RPF, in Algonquin Park. This study tracked cable and grapple skidder loads and cycle times through varying terrain in a forest of the Ottawa Valley. Through the data collected in this study, volume per PMH is able to be calculated on average with the different skid distances and the different terrain. Ideal skidding distances can also be determined with use of this study based on volume extracted per PMH and correlating this to current wood prices.

This study is then used in the machine calculations for this plan. From the PMH found in the study by Dombroskie (2012), productivity can be determined. This productivity is then used to calculate the cost per cubic metre of wood extract from the bush. The machine costing model layout is found in Appendix VIII

Using Microsoft Excel, a decision support model was built comparing potential gross revenue between the mills of the area based on the different species they accept.

Figure 2 shows the model built and used to calculated potential gross revenue for different mills and species. This model is used by selecting a mill from the drop down list, "Jovalco (Litchfield)", a local pulp mill, was selected in this scenario. Next, species are selected in the species column. The species selected are those being hauled to the mill and that have been scaled. The species use the common forest inventory code of Ontario and are set on a drop down list as well. For species like white pine, there is the option of picking different grades such as Pw2, indicated white pine grade 2. This is only used for specific mills such as Lefebvre et Pharand. When there is no need to indicate log grade, or log grade is too difficult to predict, the simple species code can be simply inputed. For many of the mills used in this model, grade is difficult to assess from an operator's point of view, thus an average price per GMT was used when a mill assess based on log grade. But as stated previously, white pine grade can be more easily predicted in the case of wood hauling to Lefebvre and Pharand and therefore can be input into the model.

| Gross Revenue Calculator | | | | | |
|---|---|---|---|---|---|
| | Mill: | Jovalco (Litchfield) | | | |
| | Species | Volume ($m^3$) | GMT | Price/GMT | Revenue ($) |
| Species 1 | ConMix | 36 | 32.40 | 23.30 | 754.92 |
| Species 2 | | | 0 | 0 | 0 |
| Species 3 | | | 0 | 0 | 0 |
| Species 4 | | | 0 | 0 | 0 |
| Species 5 | | | 0 | 0 | 0 |
| Species 6 | | | 0 | 0 | 0 |
| Totals | | 36 | 32.40 | | $ 754.92 |

Figure 2. Gross revenue based on mill and species decision support model.

The next step is to input the measured volume of each species next to its respective species in the volume column. This number is usually garnered through scaling the wood at the site before it is loaded onto a truck. By separating the measured volumes of each species, a conversion factor can run in the model that converts each species volume in metres cube to GMT. As GMT is the easiest and most used way to pay for wood at a mill, this is the preferred method to then calculated the total gross revenue of the load.

The conversion from volume ($m^3$) to GMT is done with the following formula. Gross Metric Tonne (GMT) = Wet wood density ($kg/m^3$) * Volume ($m^3$). This formula, in the model, uses the “IF(ISNA” formula with the “VLOOKUP” formula to find the corresponding values of density for the selected species. It is also found in Appendix IV. The “IF(ISNA” formula ensures that the cell will not show “N/A” when there are no input values. The VLOOKUP formula then searches for the corresponding density ($kg/m^3$) for the species indicated in the column of “Species 1”. The density is then multiplied by the value found in the Volume ($m^3$) column. A GMT value for the selected species of the row is then found in the GMT column. This value is used to determine the revenue for that species and overall. The densities that correspond to the respective species are located in Appendix IX. These are the $kg/m^3$ values for different Ontario species as indicated in the Ontario Scaling Manual (2007).

The Price/GMT is calculated with the formula found in Appendix III. Similar to the previous GMT formula, this formula uses the “IF” and “VLOOKUP” formulas to find the associating values needed for the price for a GMT.

With the use of the revenue calculator, the machine costing model and trucking costs, different scenarios were run to determine at what extent launching cut-and-skid operations in the Ottawa Valley is a feasible endeavour.

These scenarios accounted for different species compositions and different trucking rates while keeping consistent with mill pricing, wood densities for each species and machine costing. A scenario is run by choosing a species, and an amount of that species to haul, in cubic metres. Then by changing the trucking price and the mill that it is being sent to, feasibility can be determined by observing the net profit. The species being hauled can also be changed as well to examine different scenarios as different species will generate different amounts of revenue.

The acceptable species and their respective mills that are used in the model are found in Appendix VI. Here, the type of wood is also indicated whether it be pulp, saw logs or graded white pine.

Appendix III and IV shows the calculations used in the revenue calculator and Appendix V shows the layout of the revenue calculator.

# RESULTS

## AREA

The area studied is the area known as the Ottawa Valley. As there is no specific definition to where these borders are, for the purpose of this study, it is assumed to be an area with a 135km approximate radius around Pembroke, Ontario. Including area within the Ottawa Valley Forest Sustainable Forest License (SFL), this area also includes parts of Quebec as well as parts of Algonquin Park. Algonquin Park is managed by the Algonquin Forestry Authority. There is also a large amount of private forested land that can be harvested, especially on the Quebec side of the study area. Figure 1 shows a broad image of most of the area of concern surround the city of Pembroke. Much of the towns on this map are very small and surrounded by a large amount of forested and farm land. An aerial image of the land that differentiates the farmland and forestland is found in Appendix II.

The forests of the Ottawa Valley are known to have a strong presence of hardwoods such as maples, beech, yellow birch and more (AFA 2018). Also, there is a very large amount of white pine in the area with many stands exclusively comprised of mature white pine. Especially on the Quebec side, the terrain becomes very mountainous and hilly. This is very difficult for the newer mechanized harvesting operations but is still very feasible for cut-and-skid crews. There is still a presence of cut-and-skid operations in this portion of the Ottawa Valley due to the difficult terrain.

PRODUCTION

The production values that are later used in the costing analysis were procured from a time study done in Algonquin park by Shaun Dombroskie (2012). These sets of data show average skidder cycle times that can be used to predict the average productivity that a skidder will have in similar operational scenarios.

Table 1 shows the average rates of production of a Timberjack cable skidder that was tracked Algonquin Park (Dombroskie 2012). These data show the utilization of the skidder which can be used later to find the practical volume/PMH and volume/SMH. The theoretical volumes found in this table show the actual volume extracted from the bush for an hour of productive work. This also gives the hitches or loads per day expressed as loads per hour, i.e. 3.6 hitches/PMH. In Dombroskie's time study, he analyzes the numbers used from the practical analysis and not the theoretical analysis, which are these numbers. As both sets of data work, for this study, the theoretical data is used as it is applied over the long term. Appendix X shows the entire data table for the Timberjack time study with the separate production values for each skidder trip. Appendix XI shows the time study production values for the John Deere 540 Cable Skidder.

Table 1. Average actual production rates of a Timberjack 360 cable skidder in Algonquin Park (Dombroskie 2012).

| Distance (m) | % Utilization (PMH/SMH) | Volume ($m^3$) | Hitches/PMH | $m^3$/PMH | $m^3$/SMH |
|---|---|---|---|---|---|
| 388.83 | 94.66% | 4.69 | 3.60 | 16.38 | 15.50 |

Table 2 shows the production values during the same time study but of a John Deere skidder. This test used longer skid distances with a different skidder. This table shows the average distance that the skidder was tracked for hauling as well as the average volume and the resulting utilization in a percentage. The hitches per hour and the cubic meters per hour as actual values. These numbers, with the values from the Timberjack study, can be used to show average cable skidder production in a similar harvest scenario.

Table 2. Production time study averages for John Deere 540 cable skidder in Algonquin Park (Dombroskie 2012).

| Distance (m) | Volume ($m^3$) | % Utilization (PMH/SMH) | Hitches/PMH | $m^3$/PMH | $m^3$/SMH |
|---|---|---|---|---|---|
| 979.43 | 6.31 | 70% | 2.58 | 14.83 | 10.32 |

To determine cut-and-skid operation feasibility in the Ottawa Valley, production values, machine and labour costing values and revenue were determined. Productivity results are graphed as figures 3-5. Also, the scenarios run produced different net revenue results depending on inputs.

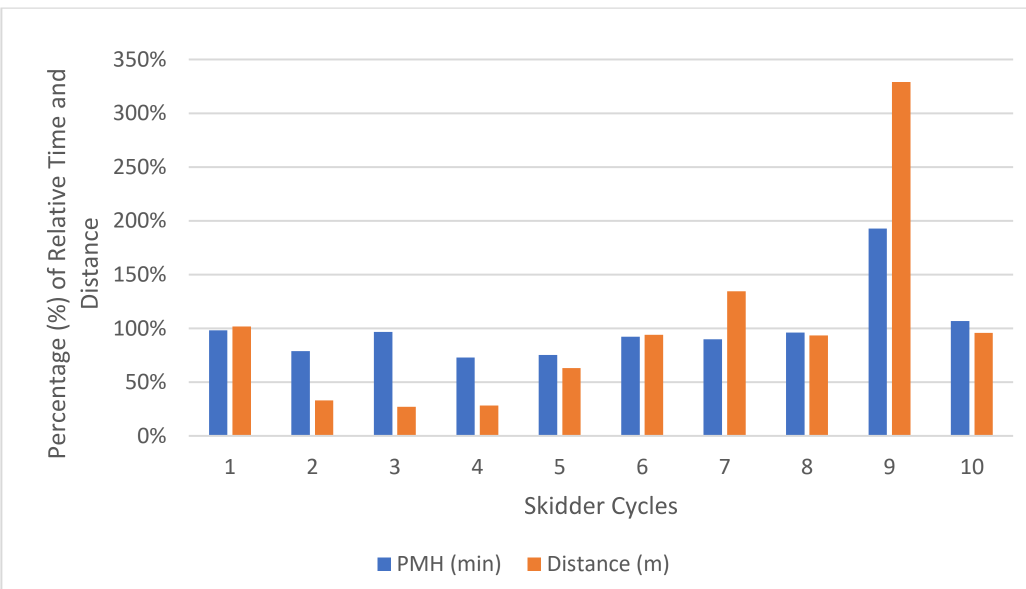


Figure 3. Relative difference between time and distance for skidder cycles based off of the average PMH and distance.

Figure 3 shows a comparison between the PMH and distances of the measured skidder cycles of the Timberjack in Dombroskie's time study. PMH and distance are referenced as a relative percentage based off of the average PMH and distances obtained by this skidder. By viewing them in a relative sense, we can see the correlation of time and distance. This is contrasted by figure 4 below that shows the distance and PMH graphed in an actual and non-relative representation. When measuring cable skidder cycle times, the travel time is dependant of distance and load size. The time taken to exit the cab and hitch the logs adds to the overall cycle time and is mainly dependant on piece size and proximity to the skidder. Distance, as shown in this table, has more of an impact on cycle time than volume does. It also indicates that distance affects PMH more than the time to hitch the logs. As hitching does affect cycle time, it does not affect as much as distance. Hitching time affects the cycle time as a constant and distance affects the cycle time as a variable. The relation between distance and cycle time of figure3 shows that trail length will affect productivity significantly.

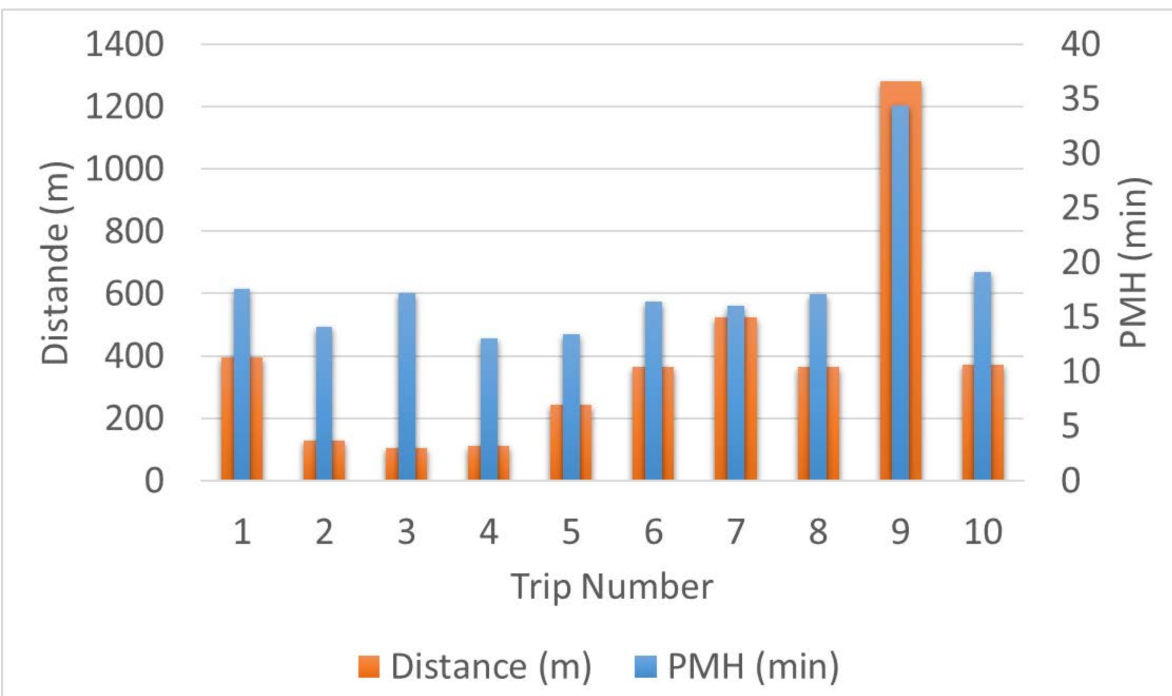


Figure 4. Actual distance and PMH graphed with respective y axis for the Timberjack time study.

Unlike the previous figure 3, figure 4 shows the actual distance and PMH graphed on separate y axis. This graph shows the differences in change between distance and PMH as opposed to the relative relation. Here it is able to be deduced that there is less variation in PMH with the shorter skid distances ash shown in the first 8 trips. Especially for trips 3, 6, and 7 where the PMH changes very little but the distance varies significantly. From these short distances, though the values vary compared to the graph showing the relative relation between distance and PMH, the same conclusion can be met that hitching has a larger impact on the PMH short distances due to its slight variation. By looking at trip 9, it can be also concluded that distance increases more, compared the first 8 trips, the PMH becomes more correlated to the increasing distance.

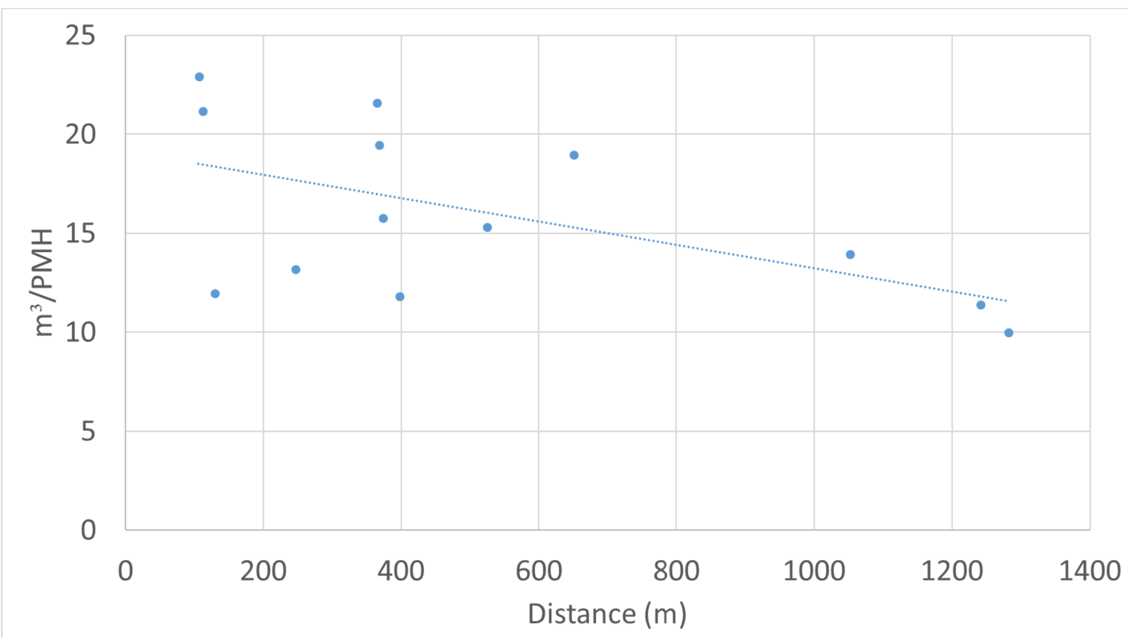


Figure 5. PMH/Volume plotted against skidder trip distance for the Timberjack and John Deere time studies.

Figure 5 shows the results of the time study for the Timberjack as well as the John Deere cable skidders. This figure shows an average linear decline in productivity with an increase of skid distance.

## MACHINE COSTING

Machine costing is done through the machine costing excel model found in Appendix VIII. This model takes into account all the values that will require a cost from the machines being used in the operation. The three main machines being used are the cable skidder, chainsaw and the company truck. This model accounts for 242 working days a year as well as 10 SMH/day. From this, there are labour costs that are calculated based on these set inputs. The initial machine price is also calculated with an estimated future salvage value. All fuel and oil prices are accounted for based on actual current prices.

The production values are then inputted to show the cost per $m^3$ for each machine operating. These costs per $m^3$ are then added up to get a total cost for the machines. This cost is then used to calculate the total cost for the scenario based on the total volume harvested.

In this calculation, the chainsaw and the cable skidder are calculated together because the operator costs remain consistent. This overall operational scenario has two operators for a cut-and-skid crew. Table 3 shows the total cost/$m^3$ for the machines used in the costing model. The cut-and-skid crew have a total cost of 5.65$/$m^3$ and the company vehicle has a cost of 0.88$/$m^3$. The total cost per cubic metre for a cut-and-skid operation, considering the machines, is 6.53$/$m^3$. This does not account for trucking costs as trucking is an outside expense being taking into account as if it were contracted out and not done internally.

Table 3. Equipment costing model results for cable skidder and chainsaw as well as company vehicle. Measured in $\$/m^3$.

| Equipment | Cut-and-Skid Crew | Crew vehicle |
|---|---|---|
| **Cost per $m^3$, $\$/m^3$** | $ 5.65 | $ 0.88 |
| **TOTAL COST PER $M^3$** | | $ 6.53 |

The production and machine cost values were generally kept consistent throughout the testing scenarios to make it easier to compare wood species and different mill prices.

TRUCKING

Trucking costs need to be accounted for when determining overall feasibility. The trucking and hauling costs were determined from E. Schutt and Sons Logging. This company provided the average trucking costs for different species at different distances when the trucking is being contracted out.

The trucking costs are based on species and distance to mill. The cost is measured in $/GMT. The set cost for trucking is then multiplied by the GMT of wood be hauled to the mill. The rate at which wood is hauled does depend on distance and species, though it does not vary at a linear or exponential rate (Schutt 2018). Trucking rates are assumed to be based off of distance, species and market condition. For these scenarios, it is assumed high to account for price changes and uncertainties.

Trucking rates for this study are assumed based off real numbers. Trucking rates vary frequently and are difficult to predict in a model. The rate of 19 $/GMT was assumed for a base white pine load scenario. In this scenario the hauling is assumed to be coming going to the Hokum Mill in Killaloe, Ontario from over 100km away. The trailer would have 30.74 GMT ($36m^3$) of white pine logs for lumber. The trucking cost for this example load would be $584.14.

Trucking costs can be predicted in the field as well with numbers from trucking companies. Any trucking costs can be inputted and used to determine the total cost by adding it to the machine cost for the operation.

## MILL PRICING

The mill prices were achieved from the Pontiac Forest Products Producers Board (PFPPB). As the PFPPB regulates and aids in much of the private harvest operations in the Pontiac County (Quebec), they made available a list of all mills and their respective prices and specifications for wood. From this price list, conversion charts were able to be made that showed the $/GMT for every species for every mill in the Ottawa Valley. These prices are used in the revenue calculation.

## SCENARIO RESULTS

For a base scenario of a single white pine load, $36m^3$ would be the average volume of wood on the trailer. To test feasibility, this load would be sent to different mills to compare the potential net revenue that can be achieved from a single load. From this, a daily revenue as well as a yearly revenue can be determined. The $36m^3$ of white pine on a load ends up being 30.74 GMT. If this were sent to the Hokum mill in Killaloe, the gross revenue would be $1,523.24. With machine costs at $\$6.53/m^3$ and trucking costs at $19/GMT, the total cost for is $819.20. When hauling to Hokum, the net profit is $704.04, a good profit for a single load of wood. It is important to note that the white pine being hauled to Hokum is exclusively of good quality. If the mill in the model were to change as well as the quality of wood, the net profit would change.

Changing the mill to Lefebvre et Pharand in Mansfield, Quebec and changing the white pine to a grade 4 white pine (lowest grade) ultimately changes the net profit. If the productivity and trucking cost remain the same in this case to have an even comparison of mill and wood quality. With these new parameters, the gross revenue would be $1,136.74. As trucking and machine costs remain the same for the comparison, the total cost is the same as the last scenario. This net profit, however, is $317.55. This is significantly less than the previous scenario with Hokums mill. This shows the difference in results depending on the mill and species quality.

If the mill were to change again, this time to Jovalco in Mansfield Quebec, as well as the species change to a conifer pulp mix (ConMix), the net profit would change as well. Keeping the same total cost values, the net profit for this pulp scenario would result in a loss of $95.74. The gross revenue is significantly lower from this pulp mill, $754.92, resulting in a negative net profit.

These are some examples of scenarios to be run, but many different ones can be calculated to determine feasibility based on specific instances. Certain cases will prove feasibility and others will show that the operation will result in a loss of money.

# DISCUSSION

## PRODUCTIVITY

From the time study analyses, productivity can potentially be improved. When net revenue is low, one of the obvious ways to increase it would be to increase productivity, thus lowering cost, $\$/m^3$. Productivity can mainly be increased through skidder cycle times. By avoiding long skid distances, the volume per PMH will likely increase thus resulting in a higher productivity. This, of course, is site and condition permitting. Long skidding, in many cases can't be avoided.

If the operation does result in lower productivity, this can be offset by higher quality of wood. Dense hardwoods such as sugar maple have a higher density and value than softwoods. This means less stems can be extracted at once during a skidder cycle due the skidder load capacities. Hardwoods will have a higher value at mills which will theoretically offset the smaller skidder load size.

Productivity for cut-and-skid operations is obviously not as high as mechanized operations with feller bunchers or harvesters. Although, the relative production, due to the high-quality timber and limit site damage, is quite beneficial. There is a very low initial capital cost as well which gives more room for variation of production rates. Production rates can vary with the unpredictable terrain that is found in the area of study.

MILL COSTING ANALYSIS

Using the Mill Gross Revenue Model, scenarios were able to be run based on potential hauling situations with different specie to different mills. Problems with this model arose due to the fact that mills do not all measure the incoming logs in the same way. This means that they pay for logs in different ways. For example, some mills will pay by thousand board foot (MBF), some will pay by meter cubed (m3) and some will pay by gross metric tonne (GMT). The model, however, does account for this difference in payment method but converts everything from cubic meters to GMT.

A map with some of the mills used in the model, on the Ontario side of the Ottawa Valley, is located in Appendix I. This map shows relative proximity to the mills depending on harvesting locations.

The varying proximity to these mills will have an effect on the overall revenue mainly due to trucking costs. The trucking costs don't vary predictively but change based on species, market and expenses of the trucker. The trucking numbers are based on realist prices used by E. Schutt and Sons Logging (Schutt 2018) company. They are based off the prices for hauling certain species to certain mills. As some of these mills were consistent with the data used in this study, many of the hauling prices were able to remain the same. However, for the mills that were outside of the Ottawa Valley, the numbers retrieved from Schutt (2018) were used to calibrate predicted prices for hauling in the area. This can be used in many scenarios when determining the feasibility of operations.

The gross mill revenues were calibrated with data from AJ Nagora Logging of Pembroke Ontario (Nagora 2018). These numbers helped determine the accuracy of the ratio between cubic metres and gross revenue.

Generally, it is cheaper to haul pulpwood compared to sawlogs as their gross revenue will be lower. As shown in the scenarios, found in the Results section, it can be difficult to turn a profit with a load of pulp compared to a load of white pine sawlogs, for example. If this pulp load were still being hauled to Jovalco, with a lowered trucking cost at $16/GMT, there would be a slight profit of $106.46. If the mill in the model were to switch to Resolu in Maniwaki, with the same lowered trucking cost, the net revenue would increase to $609.39. This shows that mill choice has a significant effect on revenue. The difficulty with this is proximity to the mills and mill availability. Many times, only a single mill is available for log purchase or there is only a single mill within reasonable distance. However, by raising trucking costs, break even analyses are able to be done to determine at what extent it is better to go to a further mill, if it were higher paying, compared to a closer one. This is assuming the operations are located closer to a less paying mill.

During sustainably managed harvest operations, it cannot simply be decided to haul to a sawmill instead of a pulp mill. This is dependent on species composition of the allocated forest and the wood quality which is often predetermined. As many operations will have a combination of sawlogs and pulpwood no matter how they are cut, because harvesting must generally follow guidelines. These harvesting guidelines come in the form of tree marking which indicates which trees are to be extracted. A good rule of thumb to follow is: for every two loads of sawlogs being hauled to the mills, one load of pulpwood must also be hauled. This provides assurance that if the scenarios regarding pulp mills seem not profitable but the sawlog scenarios are, then there still will be a profit in the end if the sawlogs still produce a significant revenue.

In most cases, by increasing productivity or lower potential costs, such as trucking, lower mill prices can be offset to increase revenue. The net revenue is very dependent on mill prices as it is dependent on productivity and expenses. But as the mill is what provides the primary source of revenue, if the market is too low, increasing productivity may not be the answer to feasibility. The costing model can show infeasible situations. These situations would likely be due to low productivity, high trucking costs or low mill prices. This revenue calculation model will aid in predicting and determining the feasibility of operating in certain locations within certain market conditions.

A large portion of the low machine costs and overall feasibility of cut-and-skid operations comes from the low initial capital costs. Relative to other harvesting operations, cut-and-skid operations do not require the high initial investments that feller bunchers or forwarders would require. This results in a lower need for a high amount of SMH in a year. With the mechanized harvest systems, the maximum amount of SMH and shifts in a year is required. With a conventional cut-and-skid system, there is much leeway in this area. This system is very functional for a variety of scenarios where an operator may not be working every day i.e. farmers working only in the off season. It is a very feasible system for a person using this as a part time source of income on top of other projects. However, by maximizing SMH and scheduled workdays, the profit and overall production will increase substantially.

# CONCLUSION

The tools built and used in this study are made to assess feasibility of harvesting operations. These tools, such as the revenue calculator is a practical model that can be used in a variety of harvesting operational situations. As it is proven in this study, a cut-and-skid operation is feasible in the Ottawa Valley, there are scenarios when a single operation may not be feasible. This is dependent on the mill pricing, the current market, location, forest type and wood quality. The tools in this study make it possible for this to be predicted. The Results section shows cases when harvesting is feasible as well as where it may not be feasible and there could be a loss of capital. When using the model, it is important to maintain accurate inputs of wood density, wood moisture content, market price and costs. With realistic inputs, the model will predict outcomes that are more accurate.

Overall, launching a cut-and-skid operation in the Ottawa Valley could prove to be a feasible endeavour. With the tools built in this study, a feasible operation is more likely to succeed due to the predictability of revenue and costs.

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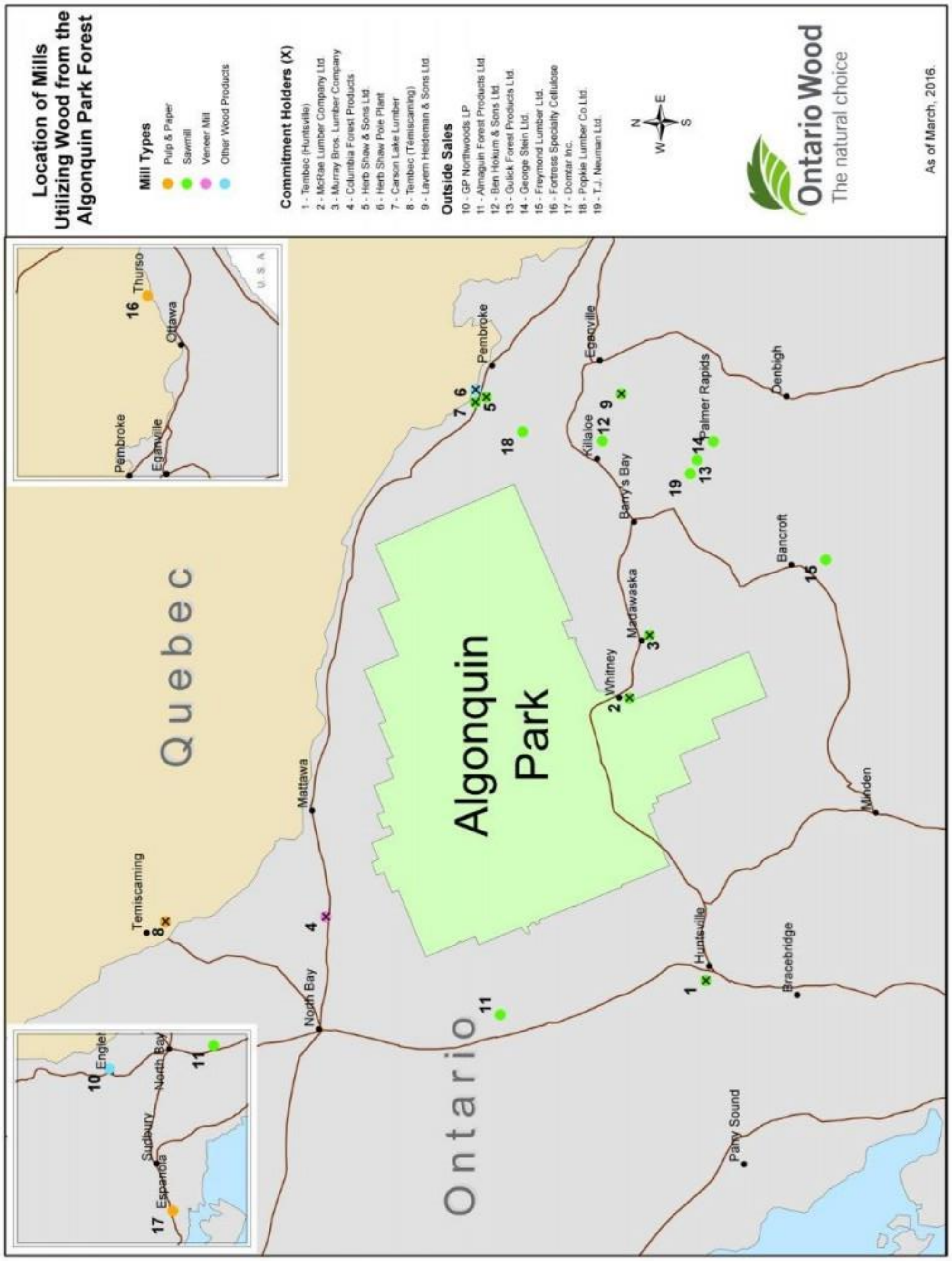
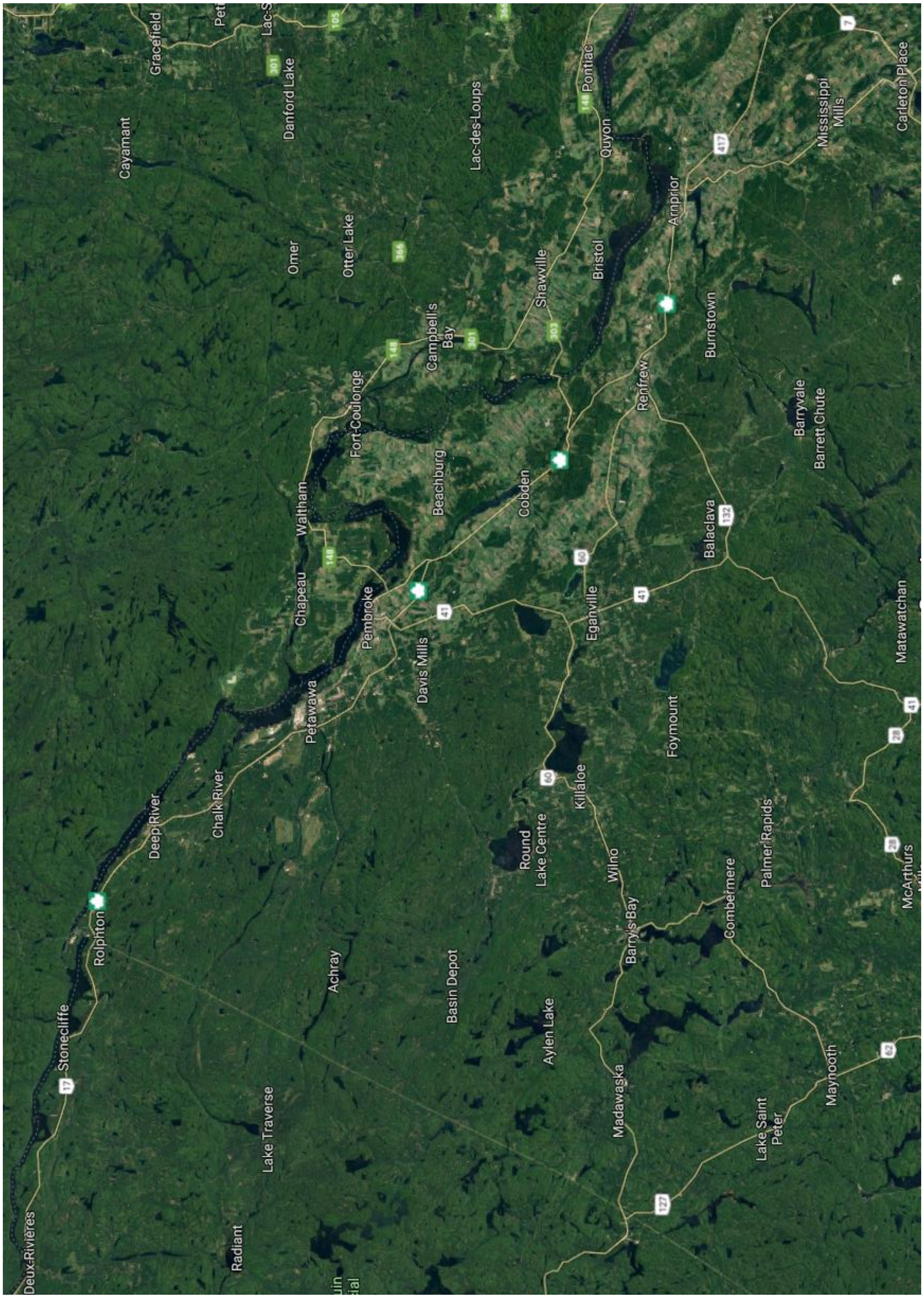
# APPENDIX I

## MILLS SURROUNDING ALONGQUIN PARK


Location of Mills Utilizing Wood from the Algonquin Park Forest
Mill Types
Pulp & Paper
Sawmill
Veneer Mill
Other Wood Products
Commitment Holders (X)
1 - Tembec (Huntsville)
2 - McRae Lumber Company Ltd.
3 - Murray Bros. Lumber Company
4 - Columbia Forest Products
5 - Herb Shaw & Sons Ltd.
6 - Herb Shaw Pole Plant
7 - Carson Lake Lumber
8 - Tembec (Témiscaming)
9 - Lavern Heideman & Sons Ltd.
Outside Sales
10 - GP Northwoods LP
11 - Almaguin Forest Products Ltd.
12 - Ben Hokum & Sons Ltd.
13 - Gulick Forest Products Ltd.
14 - George Stein Ltd.
15 - Freymond Lumber Ltd.
16 - Fortress Specialty Cellulose
17 - Domtar Inc.
18 - Popkie Lumber Co Ltd.
19 - T.J. Neuman Ltd.
N
E
S
W
Ontario Wood
The natural choice
As of March, 2016.
Quebec
Ontario
Algonquin Park
Temiscaming
Mattawa
North Bay
Huntsville
Bracebridge
Parry Sound
Minden
Bancroft
Whitney
Madawaska
Barry's Bay
Killaloe
Palmer Rapids
Denbigh
Eganville
Pembroke
Ottawa
Thurso
Sudbury
Espanola
Englet
U.S.A.

# APPENDIX II

## AERIAL IMAGE OF THE OTTAWA VALLEY


Gracefield
Cayamant
Danford Lake
Lac-des-Loups
Pontiac
Quyon
Omer
Otter Lake
Shawville
Bristol
Arnprior
Mississippi Mills
Carleton Place
Campbell's Bay
Fort-Coulonge
Renfrew
Burnstown
Beachburg
Cobden
Waltham
Barryvale
Barrett Chute
Balaclava
Chapeau
Pembroke
Davis Mills
Eganville
Matawatchan
Petawawa
Foymount
Chalk River
Deep River
Killaloe
Round Lake Centre
Palmer Rapids
Wilno
McArthurs
Rolphton
Barry's Bay
Combermere
Achray
Basin Depot
Stonecliffe
Aylen Lake
Maynooth
Lake Traverse
Madawaska
Lake Saint Peter
Radiant
Deux-Rivieres

# APPENDIX III

## REVENUE CALCULATOR PRICE/GMT CALCULATION

Ottawa Valley Species

| Gross Revenue Calculator | | | | | |
|---|---|---|---|---|---|
| | Mill: | Hokum (Killaloe) | | | |
| | Species | Volume ($m^3$) | GMT | Price/GMT | Revenue ($) |
| Species 5 | | | 0 | 0 | 0 |
| Species 6 | | | 0 | 0 | 0 |
| Totals | | 36 | 44.96 | | $ 2,227.78 |

```
=IF(ISNA(IF($E$6=$R$27,(VLOOKUP(D8,$N$40:$O$52,2,FALSE)),IF($E$6=$R$29,(VLOOKUP(D8,$N$57:$O$66,2,FALSE)),IF($E$6=$R$28,(VLOOKUP(D8,$N$82:$O$93,2,FALSE)),IF(
$E$6=$R$30,(VLOOKUP(D8,$N$75:$O$78,2,FALSE)),IF($E$6=$R$31,(VLOOKUP(D8,$N$69:$O$72,2,FALSE)))))))),"0",(IF($E$6=$R$27,(VLOOKUP(D8,$N$40:$O$52,2,FALSE)),IF($E$6=
$R$29,(VLOOKUP(D8,$N$57:$O$66,2,FALSE)),IF($E$6=$R$28,(VLOOKUP(D8,$N$82:$O$93,2,FALSE)),IF($E$6=$R$30,(VLOOKUP(D8,$N$75:$O$78,2,FALSE)),IF($E$6=$R$31,(
VLOOKUP(D8,$N$69:$O$72,2,FALSE))))))))
```

| Acceptable Species by mill | | |
|---|---|---|
| Fortress (Thurso, Qc) | Hokum (Killaloe, Ont) | Jo |
| Mh | Pw | M |
| Mr | Pr | M |
| Be | Pj | Or |
| Wn | Or | Pc |
| Cb | Ms | Cc |
| Bd | By | La |
| Ew | Bw | *p |
| Iw | Mh | |
| Hi | *sawlogs | |
| *pulp logs | | |

# APPENDIX IV

# REVENUE CALCULATOR GMT EQUATION

| Gross Revenue Calculator | | | | | |
|---|---|---|---|---|---|
| | Mill: | Resolu (Maniwaki) | | | |
| | Species | Volume ($m^3$) | GMT | Price/GMT | Revenue ($) |
| =IF(ISNA(((VLOOKUP(D8,$B$41:$E$80,2,FALSE))/1000)*E8),"0",((VLOOKUP(D8,$B$41:$E$80,2,FALSE))/1000)*E8) | | | | | |
| Species 2 | | | 0 | 0 | 0 |
| Species 3 | | | 0 | 0 | 0 |
| Species 4 | | | 0 | 0 | 0 |
| Species 5 | | | 0 | 0 | 0 |
| Species 6 | | | 0 | 0 | 0 |
| Totals | | 36 | 46.78 | | $ 1,593.00 |

| Acceptable S |
|---|
| Fortress (Thu |
| Mh |
| Mr |
| Be |
| Aw |
| Or |
| Po |
| Wn |
| Cb |
| Bd |
| Ew |
| Iw |
| Hi |
| *pulp logs |

# APPENDIX V

# GROSS REVENUE CALCULATOR

| Gross Revenue Calculator | | | | | |
|---|---|---|---|---|---|
| | Mill: | Hokum (Killaloe) | | | |
| | Species | Volume ($m^3$) | GMT | Price/GMT | Revenue ($) |
| Species 1 | Pw | 36 | 44.96 | 49.55 | 2227.78 |
| Species 2 | | | 0 | 0 | 0 |
| Species 3 | | | 0 | 0 | 0 |
| Species 4 | | | 0 | 0 | 0 |
| Species 5 | | | 0 | 0 | 0 |
| Species 6 | | | 0 | 0 | 0 |
| Totals | | 36 | 44.96 | | $ 2,227.78 |

# APPENDIX VI

# ACCEPTABLE MILL SPECIES LIST

| Acceptable Species by mill | | | | |
|---|---|---|---|---|
| Fortress (Thurso, Qc) | Hokum (Killaloe, Ont) | Jovalco (Litchfield, Qc) | Lefebvre (Mansfield, Qc) | Resolu (Maniwaki, Qc) |
| Mh | Pw | Mh | Pw1 | Sp |
| Mr | Pr | Mr | Pw2 | Pj |
| Be | Pj | Or | Pw3 | Bf |
| Ab | Sp | Ow | Pw4 | PulpMix |
| Aw | Bf | Ob | *grades of white pine | *pulp logs |
| Or | Po | Bw | | |
| Po | Pb | By | | |
| Wn | Or | Po | | |
| Cb | Ms | ConMix | | |
| Bd | By | La | | |
| Ew | Bw | *pulp logs | | |
| Iw | Mh | | | |
| Hi | *sawlogs | | | |
| *pulp logs | | | | |

# APPENDIX VI

## MILL PRICES (SOURCE: PFPPB)

| Mills in Calculator | |
|---|---|
| | |
| Fortress (Thurso) | $/GMT |
| Mh | 37.07 |
| Mr | 37.07 |
| Be | 37.07 |
| Ab | 37.07 |
| Aw | 37.07 |
| Or | 37.07 |
| Po | 29.54 |
| Wn | 29.54 |
| Cb | 29.54 |
| Bd | 29.54 |
| Ew | 29.54 |
| Iw | 29.54 |
| Hi | 29.54 |
| | |
| | |
| | |
| Jovalco (Litchfield) | |
| Mh | 30.8 |
| Mr | 30.8 |
| Or | 30.8 |
| Ow | 30.8 |
| Ob | 30.8 |
| Bw | 23.8 |
| By | 23.8 |
| Po | 23.3 |
| ConMix | 23.3 |
| La | 23.3 |
| | |

| | |
|---|---|
| Resolu (Maniwaki) | |
| Sp | 66.93 |
| Pj | 66.93 |
| Bf | 61.85 |
| PulpMix | 34.05 |
| | |
| Lefebvre et Pharand (Mansfield) | |
| Pw1 | 96.13 |
| Pw2 | 66.55 |
| Pw3 | 55.46 |
| Pw4 | 36.97 |
| | |
| | |
| Hokum (Killaloe) | |
| Pw | 49.55 |
| Pr | 48.17 |
| Pj | 37.12 |
| Sp | 44.41 |
| Bf | 37.21 |
| Po | 44.62 |
| Pb | 33.47 |
| Or | 80.43 |
| Ms | 88.44 |
| By | 72.40 |
| Bw | 52.54 |
| Mh | 120.12 |

# APPENDIX VII

## MACHINE COSTING MODEL

| Equipment | Cable Skidder | Crew vehicle |
|---|---|---|
| Number of working days/year | 242 | 242 |
| Number of SMH/day | 10 | 3 |
| Machine Utilization | 0.92 | 0.95 |
| Annual Production Estimate, m3/a | 37510 | 30976 |
| Installed or Purchase price, $ (P) | 47000 | 70000 |
| Future Salvage Value, % (FSV) | 10% | 12 |
| Future Salvage Value, $ (FSV) | 4700 | 8400 |
| Expected Economic Life-Years(EL) | 15 | 8 |
| Interest rate % | 5 | 4 |
| Fuel consumption, L/PMH | 12 | 12 |
| Fuel cost, $/L | 1.1 | 1.1 |
| Engine oil consumption, (L/PMH) | 0.1 | 0.1 |
| Oil cost, $/L | 4.35 | 4.32 |
| Hydraulic oils and/or lube L/PMH | 1.8 | 0 |
| Hydrualic oils and/or lube cost $/L | 2.84 | 2.84 |
| Annual repair and maintenance cost, % of initial purchase price | 17 | 5 |
| Operator wage, $/SMH | 25 | 0 |
| Fringe benefits cost, % of wage | 30 | 0 |
| Number of operators required/shift | 2 | 1 |
| Insurance/risk cost, % of purchase price | 3.1 | 2.4 |
| Licence cost, $/a | 0 | 2900 |
| | | |
| **SYSTEM COST SUMMARY** | | |
| Inerest rate, decimal | 0.05 | 0.04 |
| Present value of salvage vaue, $ | 22607.80361 | 6137.80 |
| Scheduled hours per year, SMH/a | 2420 | 726 |
| Productive hours per year, PMH /a | 2226.4 | 689.7 |
| | | |
| **FIXED COSTS** | | |
| Annual capital cost, $/a | 3480.390181 | 9730.83 |
| Capital Cost, $/SMH | 1.438177761 | 13.40 |
| License and insurance cost, $/a | 1457 | 4580.00 |
| | | |
| **VARIABLE COSTS** | | |
| Energy, oil and lube cost, $/PMH | 18.747 | 13.632 |
| Repair and maintenance cost, $/a | 7990 | 3500 |

| | | |
|---|---|---|
| **LABOUR COSTS** | | |
| Operator Cost, $/SMH | 65 | 0 |
| | | |
| **TOTAL COST** | | |
| Annual operating cost, $/a | 211965.711 | 27212.82 |
| Hourly operating cost, $/SMH | 87.58913677 | 37.48 |
| | | |
| **PRODUCTION** | | |
| m3 produced per SMH, m3/SMH | 15.5 | 0 |
| m3 produced per PMH, m3/PMH | 16.85 | 0 |
| **Cost per m3, $/m3** | $ 5.65 | 0.88 |
| **TOTAL COST PER M3** | | 6.53 |

# APPENDX IX

## SPECIES DENSITY IN KG/$M^3$ (SOURCE: ONTARIO SCALING MANUAL 2007)

| Wet Wood Densities | kg/m$^3$ |
|---|---|
| White Pine | 854 |
| Red Pine (plantation) | 980 |
| Red Pine | 891 |
| Jack Pine | 808 |
| Spruce | 763 |
| Hemlock | 1009 |
| Balsam Fir | 791 |
| Cedar | 569 |
| Tamarack | 994 |
| | |
| Maple | 1123 |
| Yellow Birch | 1065 |
| White Birch | 1063 |
| Oak | 1136 |
| Beech | 999 |
| Ash | 941 |
| Basswood | 841 |
| Black Cherry | 929 |
| Poplar | 918 |

# APPENDIX X

## TIMBERJACK PRODUCTION TABLE (SOURCE: DOMBROSKIE)

| TJ Cable | | | | | 60 | min/hr | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Theoretical | | | Practical | | |
| PMH (min) | Opportunity (min) | SMH (min) | Distance (m) | % Utilization (PMH/SMH) | Volume ($m^3$) | hitches/hour | m3/PMH | m3/SMH | hitches/h | m3/PMH | m3/SMH |
| 17.53 | 0.50 | 18.43 | 395.6 | 95% | 3.47 | 3.42 | 11.86 | 11.28 | 3 | 10.40 | 9.89 |
| 14.09 | 0.40 | 14.49 | 128 | 97% | 2.83 | 4.26 | 12.03 | 11.70 | 4 | 11.30 | 10.99 |
| 17.23 | 0.02 | 17.25 | 105 | 100% | 6.60 | 3.48 | 22.98 | 22.95 | 3 | 19.80 | 19.77 |
| 13.01 | 0.28 | 13.29 | 110 | 98% | 4.60 | 4.61 | 21.22 | 20.77 | 4 | 18.40 | 18.02 |
| 13.45 | 1.06 | 14.51 | 245 | 93% | 2.97 | 4.46 | 13.24 | 12.27 | 4 | 11.87 | 11.00 |
| 16.45 | 0 | 16.45 | 366 | 100% | 5.35 | 3.65 | 19.51 | 19.51 | 3 | 16.05 | 16.05 |
| 16.05 | 1.17 | 17.22 | 523 | 93% | 4.11 | 3.74 | 15.36 | 14.32 | 3 | 12.33 | 11.49 |
| 17.14 | 0 | 17.14 | 363.7 | 100% | 6.18 | 3.50 | 21.64 | 21.64 | 3 | 18.54 | 18.54 |
| 34.40 | 39.08 | 73.48 | 1280 | 47% | 5.77 | 1.74 | 10.07 | 4.71 | 1 | 5.77 | 2.70 |
| 19.08 | 0 | 19.08 | 372 | 100% | 5.04 | 3.14 | 15.84 | 15.84 | 3 | 15.11 | 15.11 |
| | | | AVG. Utilization | 92% | 4.69 | | 16.38 | 15.50 | | 13.96 | 13.36 |

# APPENDIX XI

## JOHN DEERE PRODUCTION TABLE (SOURCE: DOMBROSKIE)

| JD Cable | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 60 | min/hr | | | |
| | | | | | | Theoretical | | Practical | |
| PMH (min) | Opportunity (min) | SMH (min) | Distance (m) | Volume (m3) | % Utilization (PMH/SMH) | hitches/hour | m3/PMH | hitches/hour | m3/PMH |
| 14.45 | 35.23 | 50.08 | 648.30 | 4.58 | 0.29 | 4.15 | | 3 | 13.746 |
| 32.08 | 0 | 32.08 | 1240.00 | 6.13 | 1.00 | 1.87 | | 1 | 6.128 |
| 35.14 | 0 | 35.14 | 1050.00 | 8.21 | 1.00 | 1.71 | | 1 | 8.205 |
| Totals | | | 979.43 | 6.31 | 0.76 | 2.58 | 14.83 | | |