PROBLEM #2
PURCHASE AND CUTTING PLANS
FOR
TWO SECTIONS OF SPRUCE
IN
CANADA

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PREFACE

This report is submitted as a partial fulfillment of the requirements for the degree of Master of Forestry. The field of the problem is forest management. The purpose of the problem is to place before the student facts and data such as he might encounter in actual practice and from these have him answer certain questions which might be asked by his employer. The conclusions are made using techniques presented in courses of forest management, forest valuation and cost control in logging as presented by Professor D. M. Matthews, School of Forestry and Conservation of the University of Michigan.

The data offered in the statement of the problem were assembled by Professor Matthews from actual operating information of a Canadian company.

Hubert Harris
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Problem Number 2

The attached stand table represents the average stand per acre in a mixed spruce and balsam forest on two sections. A pulp and paper company is interested in purchasing the cutting rights for this timber or in purchasing the area outright. As forester for the company you have assembled the following data with regard to the cost of logging the area:

Transportation Investment and Costs

Rail haul to mill - $5.00 per cord

Access road from rail siding to ~~mill~~ woods - 10 miles at $2,000 per mile.

Average speed on this road is 15 m.p.h.

Interior road construction - $10 per station

Average speed on interior roads - ~~15~~ 10 m.p.h.

Truck machine rate:

Fixed cost -	$1.85	per hour
Operating cost	1.65	" "
Hauling cost	$3.50	" "

Average load - 3 cords

Operating Costs:

	Cost per minute
Felling and Limbing: Four-man crew and hornet chain saw: -	6¢
Skidding tree length logs: Tractor, sulky, driver, and one choker-man	7¢

Cross cutting

Portable slasher for cross cutting to bolt lengths:

Foreman -	$ 8.00	per day
Crew of 6 men -	43.50	" "
Slasher depreciation, etc.	6.10	" "
Total	57.60	" "

Cost per minute - 12 ¢

Cost of moving slasher - $50 per setting

Standard efficiency for the foregoing operations have been determined, by stop-watch timing, in minutes per cord for various d.b.h. classes. A schedule indicating these "normal" or "standard" times is attached hereto.

Your estimate of the efficiency which can be maintained on the operation is that it will be 60% of the standard with regard to all operations except variable skidding time per cord. As this is a function of size of load and round trip tractor speed "standard" or 100% efficiency can be assumed.

Truck Loading:

This will be done by the slasher crews and truck driver and loading will be directly to trucks from slasher platform. Theoretically loading time should vary at the same rate as slashing time, but in order to make sure that the slasher is not held up for lack of trucks the operation will be planned to allow for loading time at 45 minutes per load of 3 cords.

Unloading at Rail Siding

Time per load	30 minutes
Jammer cost	$0.45 per cord
Loading on cars	
Jammer cost	$0.45 " "
Estimated production rate	1000 cords per month
Supervision and clerical cost	$600 per month

Part I

A. Appraise the stumpage value of this stand for cutting to various d.b.h. limits - i.e., - 6" and up, 7" and up, etc. on the basis of a delivered value of $20 per cord.

B. Prepare a report for the manager of your company indicating:

1. The maximum price you would bid per cord for cutting rights on the area if the sale contract calls for the production or payment for all merchantable wood on the tract.

2. The diameter limit to which you would recommend cutting providing the owner will sell cutting rights on scale at the above bid price.

3. The price you would offer the owner for the entire property for outright purchase, based on the total stumpage recovery value he would obtain by selling on scale, plus $3 per acre for the land.

Part II

It will be assumed that your company acquires title to this tract by outright purchase. Prepare a management or cutting plan for the area which will result in the highest capital value for the property as calculated at 4% when:

A. Growth is on the residual stand is estimated at 0.2 inches d.b.h. per year.

B. The main road and interior roads can be reconditioned for use at a cost of $200 per mile at the end of any cutting cycle which may be selected.

C. Taxes are estimated to average $200 per year for the area.

Schedule of Standard Production Times

DBH	Felling and Limbing Time per Cord Crew Minutes	Fixed Tractor Time per Cord Minutes	Slasher Time per Cord Crew Minutes	Variable Skidding Time per Cord per Station Minutes
6	43.0	127	18.6	2.9
7	29.0	79	12.9	2.1
8	22.0	52	10.5	1.6
9	19.1	36	9.1	1.3
10	16.6	28	8.0	1.1
11	15.3	22	7.7	0.9
12	14.1	17	7.2	0.8
13	13.5	15	7.2	0.7
14	12.6	12	7.2	0.6
15	12.1	11	7.2	0.5
16	12.0	9	7.2	0.5
17	12.0	8	7.2	0.5
13 18	12.0	7	7.2	0.5
	233.3	423.	117.2	14.0

Average Stand Per Acre

D.B.H. Inches	No. Trees	Volume per tree cords	Total volume cords
6	10.0	.047	0.47
7	12.5	.072	0.90
8	20.0	.100	2.00
9	14.5	.137	1.99
10	17.0	.177	3.01
11	12.0	.222	2.66
12	6.2	.270	1.68
13	7.9	.331	2.61
14	2.7	.405	1.09
15	2.7	.481	1.30
16	0.9	.562	0.51
17	0.9	.657	0.59
18	0.9	.756	0.68
	108.2		19.49

INTRODUCTION

This report is submitted as an answer to the following questions asked by a prospective buyer. What is the maximum price one would bid per cord for cutting rights on two sections of spruce forest if the sale contract calls for the production or payment for all merchantable wood on the trace (6" and up)? The second question is, the diameter limit to which to cut if the present owner will sell cutting rights on scale at the above bid price. Third, the price one would offer the present owner for the entire property for outright purchase, based on the total stumpage recovery value he would obtain by selling on scale (6" and up), plus $3 per acre for the land.

Finally, on the assumption the area is purchased, prepare a management, or cutting plan for the area which will result in the highest capital value for the property as calculated at 4%.

Maximum bid per cord for cutting rights:

If the sale contract calls for the production of, or payment for all merchantable wood on the tract, i.e all trees 6" and up, the most that could feasibly be bid for the cutting rights is $2.95 per cord.

Method of determining bid price:

This figure is determined by subtracting costs per cord from the selling price per cord. First, Class "B" costs, or costs which are constant, per cord regardless of tree size, such as loading, hauling and unloading, and Class "A" costs, or costs which vary with the size of the tree such as felling and limbing, fixed skidding and cross-cutting, are calculated and subtracted from the selling price leaving the net surplus per cord for Class "C" costs and stumpage.

Class "B" costs

The Class "B" costs, being constant per-cord, will be the same for all diameter classes from 6" to 18". Since the actual loading is from the slasher platform and is done by the slasher crews, loading time and costs is included in slasher time and cost allowances and will be figured as a whole and included in Class "A" costs.

The standby time for the truck while it is being loaded is 15 minutes per cord. The hourly fixed cost of the truck, (total machine cost minus the operating cost) divided by 60 min. to give the cost per minute and multiplied by the number of minutes to load a cord, is the standby cost for trucks to load: $\frac{185¢}{60'} \times 15' = 46.3¢$ per cord.

Truck standby time to unload is 10' per cord and the cost is figured in the same manner as above:

$$\frac{185¢}{60'} \times 10' = 30.4¢ \text{ per cord.}$$

Jammer cost per cord to unload the trucks and to load the railroad cars is 45¢ for each operation or a total of 90¢.

Road haul costs on the branch roads and main roads are calculated from the same formula:

$$\text{Cost} = \frac{2 \times \text{truck machine rate}}{\text{mph on road} \times \text{truck load}} \times \text{average hauling distance.}$$

For hauling on the branch roads this is: $\frac{2 \times 350¢}{10 \text{ mph.} \times 3 \text{ cords}} \times 1 \text{ mile} = 23.3/\text{cord}$

Hauling on the main road is $\frac{2 \times 350¢}{15 \text{ mph.} \times 3 \text{ cord}} \times 10 \text{ miles} = 156¢/\text{cord}$

Supervision can be calculated on a per acre basis and included as a "B" cost $\frac{\$600/\text{mo.}}{1000 \text{ cords/mo.}} = 60¢/$ cord.

The total of these Class "B" costs is $9.06/cord. This cost is constant per cord for all diameters from 6" - 18" These calculations and a table of costs appear on page 1 of the Appendix.

Class "A" costs

Class "A" costs, or costs which vary with the size of the trees, are given for the 6" diameter class, which is the limit to which the costs must be calculated if the contract calls ~~class~~ for the production of, or payment for all merchantable wood on the tract.

It is estimated that all operations on the tract can be maintained at an efficiency 60% of standard, which is quoted in times and costs on pages 1-4, except for variable skidding which depends on tractor speed and can be assumed to be 100% efficient.

The felling and limbing cost per cord is the time required per cord multiplied by the cost per minute and an allowance of 60% of standard efficiency: $\frac{43 \text{ min. } \times 6¢}{.6}$ = $4.30/cord.

Fixed skidding cost per cord and cross-cut cost per cord are each, the time required per cord multiplied by the cost per minute and an allowance for an efficiency 60% of standard and are $14.82/cord and $3.72 per cord respectively.

The total Class "A" cost for the 6" class is $22.84.

The Class "A" and "B" costs will remain the same for the respective diameter classes regardless of the cutting or management plan to be adopted.

Net surplus before Class "C" costs:

The net surplus per cord available for Class "C" costs and stumpage is the selling price of $20.00 minus the sum of the Class "B" and "A" costs, $31.90: $20.00 - $31.90 = $-11.90/cord. As the diameter increases the Class "A" costs per cord decrease and at 8" a positive surplus is obtained. This is a point which will be discussed later.

This net surplus per unit of volume multiplied by the volume in a given diameter class gives the surplus for that class. For the 6": -$11.90/cord x 0.47 cords = $-5.50 surplus. A summation of these values for any diameter, D ~~(1)~~, and up (calculated as indicated above for all diameter classes) is the total surplus to be realized per acre cutting to that diameter limit. Cutting to a 6" limit the surplus ~~(1)~~ D and up (summation of line 10 of Table I) is +$85.44, The surplus per cord ~~(1)~~ D and up is the total surplus ~~(1)~~ D and up divided by the volume ~~(1)~~ D and up and is the surplus available for Class "C" costs and stumpage. For the 6" class: $85.44 ÷ 19.49 cords = $4.39 surplus per cord.

Class "C" costs:

Class "C" costs for a plan cutting everything 6" and up are next to be calculated.

The volume to be taken cutting 6" and up is 19.49 cords. With this volume 6" & up the slasher can be spaced along the roads most economically at 80% of road spacing. The roads then may be spaced as indicated by the formula:

$$S = \sqrt{\frac{13.0 \text{ x road cost/ sta.}}{\text{volume x variable skid cost/ cord/ sta.}}} = \sqrt{\frac{13.00 \text{ x } 1000}{19.49 \text{ x } 7.5}} = 9.4 \text{ stations.}$$

~~So~~ At this road spacing the cost per cord of building the road and the cost per cord of skidding to the slasher at the road ~~is~~ are equal. At this point also the total of the road construction and skidding costs per cord plus the slasher cost per cord is at a minimum, a total of 63.2¢

The other Class "C" cost in this instance is the cost of the main road. This cost is the total cost of building 10 miles of road divided by the number of cords to be removed from the area. In cutting all trees 6" and up.

$$\frac{\$20000}{1280\text{A x } 19.49 \text{ cords/A}} = 80.1¢ \text{ / cord}$$

Total Class "C" costs are now 63.2¢ + 80.1¢ or $1.433/cord.

Stumpage value per cord ~~(1)~~ D and up:

The surplus per cord ~~(1)~~ D and up minus the Class "C" cost, or $4.39-$1.43 = $2.95, the amount available for stumpage and hence the most that could be bid for the cutting rights if the sale contract calls for the production of, or payment for all merchantable wood on the tract, i.e. all trees 6" and up. Calculations for all these costs appear on pages 1 to 4 of the Appendix. A tabulation of values appears on Table I of the report.

Recommended diameter limit of cut:

If the owner of the area will sell cutting rights at the bid price of $2.95 per cord it is redommended that the cut be taken from 8" and up as this is the point at which the total surplus ~~(1)~~ D and up (amount available for Class "C" costs and stumpage) is greatest and the point at which the total stumpage value ~~(1)~~ D and up is at its highest.

The values for the 8" class and all other classes are determined in the same manner as described for the 6" class. The tabulation of these values for all diameter classes is shown Table I.

The net surplus per cord after Class "A" and "B" costs are deducted (line 5 of Table I) is negative for the6" and 7" diameter classes, i.e. it costs more to get trees of those diameters out of the woods than is realized from their sale. The first positive surplus is produced in the 8" diameter class and it is at this point, cutting all trees 8" and up, that the greatest total surplus ~~1~~ D and up is obtained (line 8 of Table I) due to the fact that the largest volume producing any surplus is removed at this point.

Bid price for entire property

If the owner would sell the property at a price based on the total stumpage recovery value he would obtain by selling on scale, i.e. 6" and up, plus $3.00 per acre for the land, the price to offer is $77,500.

The figure of $77,500 is obtained by multiplying the stumpage recovery value per cord at 6" and up, $2.957, by the volume per acre 6" and up, 19.49 cords, and adding $3 per acre for the land: ($2.957/cord x 19.49 cords/A)+ $3/A = $60.50, the value per acre. The value per acre multiplied by the number of acres equals the total value of the property, or the price to offer for the area: $60.50/A x 1280A = $77,500.

Part II

Management Plan for the Area:

Since the area is a spruce area and no data ~~is~~ are given as to any tree below 6" in diameter it will be assumed that this is a typical spruce stand, i.e. generally even aged and hence it will be managed for some form of liquidation cut.

A liquidation cut taking all the trees 6" and up would not be practical as it has been shown that it costs more money to remove trees 6" and 7" in diameter than is realized from their sale or manufacture and hence such a plan would operate at a loss in these diameter classes, this loss having to be taken from the total profit obtained.

A single liquidation cut taken from 8" and up, the point at which the greatest surplus per acre and highest stumpage value per acre ~~and highest stumpage value per acre~~ are gained hardly seems practical either when it is considered that the trees 6" and 7" in diameter represent part of the investment made in the purchase of the area and are likely to be lost by windthrow if such a large percentage of the volume, as represented by the volume 8" and up, is removed.

The preferred plan:

It would seem as if a plan calling for a two cut liquidation, but with the first cut taken to a higher diameter limit than 8" would be the plan on which to operate. The fact to be determined is what combination of diameter limit for the first cut and length of cutting cycle before the second cut will yield the greatest present money value for the property.

Method of calculation:

Surplus and Up

Combined surplus ~~(1)~~ D and up (before Class "C" costs) for the two cuts of any plan is used as the basis for the comparison of the various plans because the highest value at this point also produces the highest total stumpage value ~~(1)~~ D and up (after Class "C" costs) at the same diameter limit and it also obviates the necessity of making calculations of Class "C" costs for each plan to be considered. The plans considered were, cutting to each one inch diameter limit from 8" to 15" with the second cut coming in 15, 20, 25 and 30 years.

The surplus ~~(1)~~ D and up available in the stand 30 years from now is calculated as shown in the table below.

PREDICTION OF VALUES OF TWO CUT LIQUIDATION

Cut now and again in 30 years

Growth rate of 0."2/yr.

DBH	No. trees in class	Surp/tree	pres. surp. D & up	limit 8"	9"	10"	11"	12"	13"	14"	15"
				Total surplus D and up - first cut to a-							
6	10.0		85.44								
7	12.5		87.55								
8	20.0	5.7¢	90.94								
9	14.5	39.5	89.78								
10	17.0	78.3	84.06								
11	12.0	117.5	70.76								
12	6.2	165.5	56.66	16.55	16.55	16.55	16.55	16.55	16.55	16.55	16.55
13	7.9	211.5	46.40	26.40	26.40	26.40	26.40	26.40	26.40	26.40	26.40
14	2.7	276.3	29.70		55.40	55.40	55.40	55.40	55.40	55.40	55.40
15	2.7	338.0	22.24			49.00	49.00	49.00	49.00	49.00	49.00
16	0.9	411.0	13.13				69.90	69.90	69.90	69.90	69.90
17	0.9	482.0	9.43					57.80	57.80	57.80	57.80
18	0.9	565.0	5.09						35.00	35.00	35.00
19		663.0								52.40	52.40
20		771.0									20.80
				42.95	98.35	147.35	217.25	275.05	310.05	362.45	383.25

The surplus per tree for each diameter class, column 3 of the table above, is calculated by dividing the surplus for the given class (line 5 of Table I) by the number of trees in the class (from page 4). This surplus, after deducting Class "A" and "B" costs, will be the same in 30 years as it is now and does not change with the plan of management.

By cutting 12" and up now and waiting 30 years for the second cut the 10 trees in the 6" class will have grown 6" (0".2/yr for 30 years) to the 12" class and will have the surplus per tree as indicated for that class: 10 trees x \$1.655/tree= \$16.55, the surplus for the 12" class in 30 years.

Each diameter class from 6"-11" (residual stand after first cut) will have added 6" and advanced to the 12" to 17" classes respectively. The surplus for the new 12" class is calculated in the preceeding paragraph and that for all the other classes is found in the same manner and shown in Table II. The surplus per tree for 19" and 20" used in calculating other plans was obtained by graphing the surplus per tree for the classes from 8" to 18" and extending the curve to the 19" and 20" diameter classes. (p.20 - APPENDIX)

The total of the 12" column of Table II (i.e. the first cut was made to a 12" limit causing the surpluses per class to be realized in 30 years) is \$275.05. This figure discounted 30 years, calculating the investment at 4%, to give the present value of that surplus is:

$$\frac{275.05}{1.04^{30 \text{ years}}} = \frac{275.05}{3.2434} = \$84.70$$

This value plus the present surplus D and up to be obtained in cutting 12" and up (line 8 of Table I and column 4 of Table II) gives the present value of the combined surplus of the two cuts: $84.70 + $56.66 = $141.36.

The $141.36 compares favorably with the maximum value of $141.90 cutting 13" and up, which is the present value of the surplus D and up 30 years from now:

$$\frac{310.05}{1.04^{30}} = \frac{310.05}{3.2434} = \$95.50,$$ plus the present surplus D and up cutting to the 13" limit, $46.40, equals $141.90.

The calculations for all other plans are made in a like manner and appear on pages 15 to 26 of the Appendix.

Class "C" Costs of the second cut:

Road construction, skidding and slasher moving cost:

The Class "C" costs, road construction and maintenance variable skidding cost and slasher moving cost, for the second cut of the 12" - 30 year plan may now be calculated.

Since the number of trees in the higher diameter classes is greater in the second cut the volume per acre will be larger and may call for construction of additional roads.

Volume of second cut:

DBH	No. trees	vol.cords/tree	tot.vol./class in cords
12	10.0	.270	2.70
13	12.5	.331	4.14
14	20.0	.405	8.10
15	14.5	.481	6.97
16	17.0	.562	9.56
17	12.0	.657	7.89
			39.36 cords

With a volume of 39.36 cords per acre the most economical distance for spacing of slasher locations is at 80% of the road spacing. The new road spacing desired is:

$$S = \sqrt{\frac{13.0 \times 1000}{39.36 \times 4.1}} = 9 \text{ stations.}$$

This distance is the one at which the cost per cord for road construction and cost per cord of skidding to the landings are equal and is the distance at which the total of these two costs plus the slasher moving cost per cord is at a minimum:

road cost	= 12.4¢	
skidding cost to landings	= 12.4	24.8¢
slasher moving cost		7.2
		32.0¢/cord

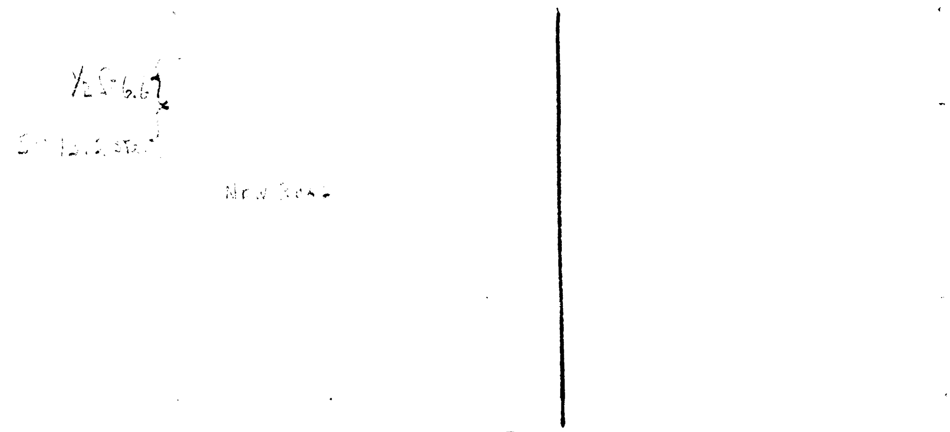
The costs per cord of reconditioning the old roads, skidding the economic distance to the landings on these roads and of slasher moving is as follows:

reconditioning of roads	10.3¢
skidding to landings at roads	12.1
slasher moving cost	8.6
	31.0¢/cord

The economic road spacing for the second cut is 9 stations which is slightly less than half the spacing of the roads that were put in at the time of the first cut. One additional branch road can be located midway between the two roads already in existence.

Three-fourths of the volume will be moved to the old roads at a cost of 31.0¢ per cord and one-fourth of the volume will be moved to the new roads at a cost of 32.0¢ per cord for a weghted average cost of 31.3¢

The actual spacing of the roads at 13.2 stations as represented in the figure below and the fact that one-fourth of the volume lies beyond the economical skidding distance, as indicated by the red shading, changes the actual cost per cord to 39.8¢ (calculations appear on page 29 of the Appendix.)



2 SECTIONS

<u>Main road reconditioning cost</u>:

The cost of reconditioning the main road is $200 a mile for 10 miles, or $2000. This cost is spread against the 50,400 cords to be taken from the area:

39.36 cords/A x 1280A = 50,400 cords. The cost per cord is:

$$\frac{\$2000}{50{,}400 \text{ cords}} = 4¢ \text{ / cord.}$$

<u>Total Class "C" costs</u>:

The sum of the Class "C" costs per cord for the second cut is 43.8¢ 39.8¢ + 4¢ = 43.8¢ / cord.

<u>Present Worth of the Property</u>:

The present worth of the property is the value of the first cut, surplus D and up before "C" costs minus the Class "C" or fixed per acre costs, or \$56.66 - \$20.80, plus the value of the second cut, the surplus D and up before Class "C" costs minus the Class "C" costs, the net surplus being discounted 30 years to give its present value, $\frac{\$275.05 - \$17.20}{1.04^{30}}$,

plus the value of \$3 per acre for the land discounted 30 years to give its present value, $\frac{\$3}{.04^{30}}$; minus taxes of 15.6¢ per acre every year for 30 years, $15.6¢ \left(\frac{1.04^{30} - 1}{.04 \times 1.04^{30}} \right)$

Actual road and skidding costs for second cut:

with effective road spacing at 26.4 station:

cost of road	= 10.3
skidding - 0.289SC = 0.289 x 26.4 x 4.1	= 31.2
slasher moving = $\frac{5000}{0.138 \times 100.4 \times 39.36}$	= 7.2
	48.7x1/4 of vol= 12.2¢

with effective road spacing at 13.2 stations

new road:

2PCS = 2X0.336x4.1x13.2 = 36.4

$\frac{L}{0.183 S^2 V} = \frac{5000}{0.183 \times 100.4 \times 39.36}$ = 7.2

43.6 x 1/4 of volume = 10.3¢

old road:

skidding: 0.289SC = 0.289 x 13.2 x 4.1 = 15.6

road maintenance $= \frac{R/12.1}{VC} = \frac{\frac{20000}{12.1}}{39.36 \times 4.1} \doteq 10.3$

slasher moving 8.6

34.5x1/2 of vol.= 17.3

39.8/cord

Total Class "C" cost:

39.8¢
+4.0
43.8¢/cord

This is the present worth of the property for the best plan of management.

Flexibility of plan:

However the plan is sufficiently flexible so that it may be modified to meet economic conditions current 20 to 30 years from now.

If at any time from 20 to 30 years after the first cut a general lowering of the selling price per cord seems imminent, with no indication of a rising market price in the near future, it would be practical to make the second cut at once in order to make the most money on the original investment, as the surplus D and up, our basis of comparison, differs only a few dollars an acre at the end of the 20, 25 and 30 year periods. The present value of the total surplus D and up for the 20 year plan is $135.96/A, $139.66/A for the 25 year plan and $141.36 for the 30 year plan.

If the stand had been carried to 30 year through a gradual price decline, with a definite increase expected shortly, the stand could be carried to 35 years with only a small decrease in value from $141.36 to $141.06 (calculation on pages 25 and 26 of the Appendix.) However this should only be done as a last resort and should not be considered the preferred policy.

A P P E N D I X

CLASS "B" COSTS

Load

truck standby:

$$\frac{180}{60'} \times 15 \text{ min} = 46.3¢$$

$$\frac{185}{60'} \times 10' = 30.4¢$$

jammer 45.

loading cars jammer 45.

90¢

Class "B" cost	
truck ~~stand by~~ load	=46.3
" " unload	=30.4
jammer	90
road haul	=179.3
R.R. haul	=500.0
supervision	60
Total	906.0¢

Class ~~"B" costs~~

wood haul:

branch roads

$$HC = \frac{2MR}{mph. \times L} = \frac{2 \times 350}{10 \times 3} = \frac{700}{30} = 23.3/\text{cord/mi} \cdot \times 1 \text{ mile} = 23.3¢$$

main road:

$$HC = \frac{2MR}{mph.xL} = \frac{2x350}{15x3} = \frac{700}{45} = 15.6/\text{cord/mi} \times 10 \text{ mi.} = 156¢$$

173.3¢

supervision

$$\frac{60000}{1000} = 60¢/\text{cord}$$

Class A costs

felling and limbing		fixed tractor cost/cord	cross cut cost/cord
6"	430¢	127 min.x 7¢ min = $\frac{890}{.6}$ = 1482¢	18.6 min.x 12¢/min = $\frac{223.2}{.6}$ = 372¢
7"	290¢	79 x 7 = $\frac{554}{.6}$ = 923	12.9 x 12 = $\frac{154.9}{.6}$ = 258
8"	220¢	52 x 7 = $\frac{364}{.6}$ = 606	10.5 x 12 = $\frac{126.}{.6}$ = 210
9"	191¢	36 x 7 = $\frac{260}{.6}$ = 433.5	9.1 x 12 = $\frac{109.1}{.6}$ = 182
10"	166¢	28 x 7 = $\frac{196}{.6}$ = 326.5	8.0 x 12 ≑ $\frac{96.0}{.6}$ = 160
11"	153¢	22 x 7 = $\frac{154}{.6}$ = 256.4	7.7 x 12 = $\frac{92.4}{.6}$ = 154
12"	141¢	17 x 7 = $\frac{119}{.6}$ = 198.3	7.2 x 12 = $\frac{86.4}{.6}$ = 144
13"	135¢	15 x 7 = $\frac{105}{.6}$ = 175.0	7.2 x 12 = $\frac{86.4}{.6}$ = 144
14"	126¢	12 x 7 = $\frac{84}{.6}$ = 140.0	7.2 x 12 = $\frac{86.4}{.6}$ = 144
15"	121¢	11 x 7 = $\frac{77}{.6}$ = 128.2	7.2 x 12 = $\frac{86.4}{.6}$ = 144
16"	120¢	9 x 7 = $\frac{63}{.6}$ = 105.0	7.2 x 12 = $\frac{86.4}{.6}$ = 144
17"	120¢	8 x 7 = $\frac{56}{.6}$ = 93.4	7.2 x 12 = $\frac{86.4}{.6}$ = 144
18"	120¢	7 x 7 = $\frac{49}{.6}$ = 81.6	7.2 x 12 = $\frac{86.4}{.6}$ = 144

Tot Class A costs per cord

6"	7"	8"	9"	10"
430	290	220	191	166
1482	923	606	433.5	326.5
372	258	210	182	160
2284.0	1471.0	1036.0	806.5	652.5

11"	12"	13"	14"	15"
153	141	135	126	121
256.4	198.3	175	140.0	128.2
154.0	144	144.	144.	144
563.4	483.3	454.0	410.0	393.2

16"	17"	18"
120	120	120
105	93.4	81.6
144	144	144.0
369.0	357.4	345.6

Cut
6" and Up

Variable skid. cost: 1.08 min/cord-avg. skid time x 7¢/min=7.54 or 7.5 /cord/sta.

Vol. 6" and up. = 19.49 cords

$$S = \sqrt{\frac{17.4 \times 1000}{19.49 \times 7.5}} = \sqrt{\frac{17,400}{146}} = \sqrt{119.1} = 10.9$$

trial calculation with the ~~slacker~~ slasher @ 12 1/2% of road spacing

$$2\,PCS = 2 \times 0.2525 \times 7.5 \times 10.9 = 41.3$$

$$\frac{L}{0.02875\ v} = \frac{5000}{0.0287\ \ 119 \times 19.49} = 75.2$$

$$\frac{41.3}{75.2} = 0.55 \quad \therefore Z = 80\%$$

$$S = \sqrt{\frac{13.0 \times 1000}{19.49 \times 7.5}} = \sqrt{\frac{13,000}{146}} = \sqrt{89} = 9.4 \text{ sta.}$$

Cost of roads, skid and ~~slack~~ slasher

$$2\,PCS = 2 \times 0.336 \times 7.5 \times 9.4 = 47.4¢$$

$$\frac{L}{0.183\ \ V} = \frac{5000}{0.183 \times 89 \times 19.49} = 15.8¢$$

63.2¢ cost/cord

Cut 7" and up

Variable skid cost.

0.'925 avg.skid time/~~cost~~ cord x 7¢/min.= 6.48 or 6.5¢/sta./cord.

Vol. 7" and up = 19.02

$$S = \sqrt{\frac{17.4 \times 1000}{19.02 \times 6.5}} = \sqrt{\frac{17,400}{123.7}} = \sqrt{140.8} \qquad \underline{11.9 \text{ sta.}}$$

trial calculation slasher sa at 12-1/2% of spacing

2 PCS = 2 x 0.2525 x 6.5 x 11.4 = 39.1

$$\frac{L}{0.02878 \quad V} \qquad \frac{5000}{0.0287 \times 140.8 \times 1902} = 65.2$$

$$\frac{39.1}{65.2} = 0.574 \quad \therefore \quad \underline{Z = 80\%}$$

$$S \doteq \sqrt{\frac{13.0 \times 1000}{19.02 \times 6.5}} = \sqrt{\frac{13000}{123.7}} = \sqrt{105} \quad = \underline{10.2 \text{ sta.}}$$

Cost

2 PCS = 2 x 0.336 x 6.5 x 10.2 = 44.5

$$\frac{L}{0.183 \quad V} = \frac{5000}{0.183 \times 105 \times 19.02} = \frac{13.7}{58.2¢} \text{ cost/cord}$$

line		6	7	8	9	10	11	12	13	14	15	16	17	18
1	Val./cord	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
2	Class B cost/cord	906	906	906	906	906	906	906	906	906	906	906	906	906
3	balance	1094	1094	10940	1094	1094	1094	1094	1094	1094	1094	1094	1094	10940
4	Class A costs/cord	2284 0	14710	10360	8065	6525	5634	4833	4540	4100	3932	3690	3574	3450
5	Net surplus/cord	1190 0	377	+580	2875	4415	5306	6107	6400	6840	7008	7250	7366	7484
6	vol./class	0.47	0.90	2.00	1.99	3.01	3.01	1.68	2.61	1.09	1.30	0.51	0.59	0.68
7	surplus for class	-550	-339	+116	572	1330	1410	1026	1670	746	911	370	434	509
8	supr.D & up	8544	8755	9094	8998	8406	7076	5666	4640	2970	2224	1313	943	509
9	vol.D & up	19.49	19.02	18.12	16.12	14.13	11.12	8.46	6.78	4.17	3.08	1.78	1.27	0.68
10	suprlus/cord D & up	439	460	501	556	595	6355	669	6845	711	723	759	7425	748
11	Class C costs/cord	143 3	1402	1411	1514	1638	1968	246	2955	451				
12	Stump.value/cord D & up	295 7	3198	3599	4046	4312	4387	423	3890	260				
13	vol.D & up	19.49	1902	1812	1612	1413	1112	846	678					
14	stumpage value D & up	57.50	6080	6520	6520	6160	4880	3580	2640					

TABLE OF COSTS AND VALUES
FOR ONE ACRE OF SPRUCE IN
CANADA

TABLE I

8" and up

Variable skid cut:

0.818 avg.skid time/cord x 7¢/min = 5.73 = 5.7¢ cord/str.

Vol. 8" and up. 18.12

$$S = \sqrt{\frac{17.4 \times 1000}{18.12 \times 5.7}} = \sqrt{\frac{17,400}{103.2}} = \sqrt{168.5} = 13.0 \text{ sta.}$$

calculation with slasher spacing at 12 1/2% of road spacing

2PCS = 2 x 0.2525 x 5.7 x 13 = 37.4

$$\frac{L}{0.0287S^2V} \qquad \frac{5000}{0.0287 \times 168.5 \times 18.12} = 57.0$$

$$\frac{37.4}{57.0} = 0.655 \qquad Z = 80\%$$

$$S = \sqrt{\frac{13.0 \times 1000}{18.12 \times 5.7}} = \sqrt{\frac{13,000}{103.2}} = \sqrt{126.0} = 11.2 \text{ sta.}$$

Cost

2PCS = 2 x 0.336 x 5.7 x 11.2 = 42.9

$$\frac{L}{0.183S^2 V} \qquad \frac{5000}{0.183 \times 126 \times 18.12} = \frac{12.0}{54.9¢ \text{ cost/cord}}$$

Cut 9" and up

Variable skid cut:

0'.74 avg. skid time/sta./cord x 7¢ /min = 51.8¢ = 5.2¢/cord/sta.

vol. 9" and up.

16.12 cords

$$S = \sqrt{\frac{17.4 \times 1000}{16.12 \times 5.2}} = \sqrt{\frac{17,400}{84}} = \sqrt{207.5} = 14.2 \text{ sta.}$$

trial calculation with slasher spaced at 12-1/2% of road spacing

$$2PCS = 2 \times 0.2525 \times 5.2 \times 14.2 = 37.3$$

$$\frac{L}{0.0287\ S^2 V} = \frac{5000}{0.0287 \times 207.5 \times 16.12} = 52.1$$

$$\frac{37.3}{52.1} = 0.715 \quad \therefore Z = 80\%$$

$$S = \sqrt{\frac{13.0 \times 1000}{16.12 \times 5.2}} = \sqrt{\frac{13000}{84}} = \sqrt{154.9} = 12.4 \text{ sta.}$$

cost

$$2PCS = 2 \times 0.336 \times 5.2 \times 12.4 = 43.4$$

$$\frac{L}{0.183\ S\ 2\ V} \qquad \frac{5000}{0.183 \times 154.9 \times 16.12} = \frac{11.0}{54.4¢\text{/cord}}$$

<u>10" and up</u>

variable skid cost:

0.678 avg. skid time/cord x 7¢ /min. = 4.74 or 4.7¢/cord/sta.

vol. 10" and up = 14.13 cords

$$S = \sqrt{\frac{17.4 \times 1000}{14.13 \times 4.7}} = \sqrt{\frac{17,400}{66.5}} = \sqrt{262} = 16.1 \text{ sta.}$$

trial calculation with slasher spacing at 12-1/2% of road spacing

$$2PCS = 2 \times 0.2525 \times 4.7 \times 16.1 = 38.2$$

$$\frac{L}{0.0287\ S^2\ V} \quad \frac{5000}{0.0287 \times 262 \times 14.13} = 47$$

$$\frac{38.2}{47} = 0.813 \quad \therefore Z = 70\%$$

$$S = \sqrt{\frac{13.6 \times 1000}{14.13 \times 4.7}} = \sqrt{\frac{13,600}{66.5}} = \sqrt{204.3} = 14.2 \text{ sta.}$$

<u>cost</u>

$$2PCS = 2 \times 0.319 \times 4.7 \times 14.2 = 42.6$$

$$\frac{L}{0.161 S^2\ V} = \frac{5000}{0.161 \times 204.3 \times 14.13} = \frac{10.7}{53.3¢} \text{ / cord}$$

Cut 11" and up

Variable skid cost:

0'.625 avg.skid time/cord x 7¢/min = 4.37 or 4.4¢/cord/sta.

Volume 11" and up = 11.12 cords

$$S = \sqrt{\frac{17.4 \times 1000}{11.12 \times 4.4}} = \sqrt{\frac{17,400}{49}} = \sqrt{355} = 18.9 \text{ sta.}$$

trial calculation with slasher spacing at 12-1/2% of road spacing

2PCS = 2 x 0.2525 x 4.4. x 18.9 = 42

$$\frac{L}{0.02875\ 2\ V} \qquad \frac{5000}{0.0287 \times 355 \times 11.12} = 44$$

$$\frac{42}{44} = 0.955 \quad \therefore \quad Z = 70\%$$

$$S = \sqrt{\frac{13.6 \times 1000}{11.12 \times 4.4}} = \sqrt{\frac{13,600}{49}} = \sqrt{277} = 16.5 \text{ sta.}$$

cost

2PCS = 2 x 0.319 x 4.4 x 16.5 = 46.2

$$\frac{L}{0.161S^2V} \qquad \frac{5000}{0.161 \times 277 \times 11.12} = \quad 10.1$$

56.3¢/cord

Cut 12" and up

Variable skid cost:

0'.586 min.avg.skid time/cord x 7¢/min = 4.1¢/cord/sta.

Vol 12" and up = 846 cords

$$S = \sqrt{\frac{17.4 \times 1000}{8.64 \times 4.1}} = \sqrt{\frac{17,400}{34.7}} = \sqrt{501} = 22.5 \text{ sta.}$$

trial calculations with slashed spacing at 12-1/2% of road spacing

$$2PCS = 2 \times 0.2525 \times 4.1 \times 22.5 = 46.6$$

$$\frac{L}{0.0287S2V} \qquad \frac{5000}{0.0287 \times 501 \times 8.46} = 41.1$$

$$\frac{46.6}{41.1} = 1.135:1 \quad \therefore Z = 60\%$$

$$S = \sqrt{\frac{14.3 \times 1000}{8.46 \times 4.1}} = \sqrt{\frac{14,300}{34.7}} = \sqrt{412} \qquad 20.4 \text{ sta}$$

Cost

$$2PCS = 2 \times 0.304 \times 4.1 \times 20.4 = \qquad 50.9$$

$$\frac{L}{0.138S2V} \qquad \frac{5000}{0.138 \times 412 \times 8.46} = 10.4$$

61.3¢/cord

13" and up

Variable Skid cost

0'.55 min. - avg. skid time/sta/cord x 7¢/min. = 3.85 =3.9¢sta/cord

Volume 13" and up: = 6.78 cords

$$S = \sqrt{\frac{17.4 \times 1000}{6.78 \times 3.9}} = \sqrt{\frac{17,400}{26.4}} = \sqrt{660} = 25.8 \text{ sta.}$$

trial calculation with slasher spacing at 12-1/2% of road spacing

2 PCS = 2 x 0.2525 x 3.9 x 25.8 = 50.9

$$\frac{L}{0.0287S^2V} = \frac{5000}{0.0287 \times 660 \times 6.78} = 39.0$$

$$\frac{50.9}{39.0} = 1.3:1 \quad \therefore Z = 60\%$$

$$S = \sqrt{\frac{14.3 \times 1000}{6.78 \times 3.9}} = \sqrt{\frac{14,300}{26.4}} = \sqrt{541} = 23.3 \text{ sta.}$$

cost

2 PCS = 2 x 0.304 x 3.9 x 23.3 = 52.2

$$\frac{L}{0.138S^2V} \quad \frac{5000}{0.138 \times 541 \times 6.78} = 9.9$$

65.1¢/cord

14" and up

Variable skid. cost.

0.52 min. avg. skid. time/sta/cord x 7¢/min = 3.64 or 3.6¢/cord/sta

Vol. 14" and up = 4.17 cords

$$S = \sqrt{\frac{17.4 \times 1000}{4.17 \times 3.6}} = \sqrt{\frac{17,400}{15.01}} = \sqrt{1159} = 34 \text{ sta.}$$

Trial calc. without slasher spacing at 12-1/2% of road spacig

$$2PCS = 2 \times 0.2525 \times 3.6 \times 34 = 61.9$$

$$\frac{L}{0.02875^2V} \qquad \frac{5000}{0.0287 \times 1159 \times 4.17} = 36.1$$

$$\frac{61.9}{36.1} = 1.76 + 1 \quad \therefore Z = 60\%$$

$$S = \sqrt{\frac{14.3 \times 1000}{4.17 \times 3.6}} = \sqrt{\frac{14,300}{15.01}} \approx \sqrt{951} = 31 \text{ sta.}$$

Cost

$$2PCS = 2 \times 0.304 \times 3.6 \times 31 = 67.9$$

$$\frac{L}{0.138S^2V} = \frac{5000}{0.138 \times 951 \times 4.17} = \underline{9.1}$$

77.0¢ / cord

Cost of main road reconditioning			road par. skid cost	Tot. Class C costs
6" and up	$\frac{\$20000}{1280A \times 19.49 \text{ cds/A}}$	= 80.1¢/cord	63.2	143.3¢/cord
7" up	$\frac{\$20000}{1280A \times 19.02}$	= 82¢/ cord	58.2	140.2¢/cord
8" up	$\frac{\$20000}{1280A \times 18.12}$	= 86.2¢/cord	54.9	141.1¢/cord
9" up	$\frac{\$20000}{1280A \times 16.12}$	= 97¢/cord	54.4	151.4¢/cord
10" up	$\frac{\$20000}{1280A \times 14.13}$	= 110.5¢/cord	53.3	163.8¢/cord
11" up	$\frac{\$20000}{1280A \times 11.12}$	= 140.5¢/cord	56.3	198.8¢/cord
12" up	$\frac{\$20000}{1280A \times 8.46}$	= 184.7¢/cord	61.3	246.0¢/cord
13" up	$\frac{\$20000}{1280A \times 6.78}$	= 230.4¢/cord	65.1	295.5¢/cord
14" up	$\frac{\$20000}{1280A \times 4.17}$	= 374.0¢/cord	77.0	451.0¢/cord

line		6	7	8	9	10	11	12	13	14	15	16	17	18
1	Val./cord	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
2	Class B cost/cord	906	906	906	906	906	96	906	906	906	906	906	906	906
3	balance	1094	1094	10940	1094	1094	1094	1094	1094	1094	1094	1094	1054	10940
4	Class A costs/cord	2284 0	14710	10360	8065	6525	5634	4833	4540	4100	3932	3690	3574	3450
5	Net surplus/cord	1190 0	377	+560	2875	4415	5306	6107	6400	6840	7008	7250	7366	7484
6	vol./class	0.47	0.90	2.00	1.99	3.01	3.01	1.68	2.61	1.09	1.30	0.51	0.59	0.68
7	surplus for class	-550	-339	+116	572	1330	1410	1026	1670	746	911	370	434	509
8	supr.D & up	8544	8755	9094	8998	8406	7076	5666	4640	2970	2224	1313	943	509
9	vol.D & up	19.49	1902	18.12	16.12	14.13	11.12	8.46	6.78	4.17	3.08	1.78	1.27	0.68
10	suprlus/cord D & up	439	460	501	556	595	6355	669	6845	711	723	759	7485	748
11	Class C costs/cord	143 3	1402	1411	1514	1638	1968	246	2955	4[illegible]1				
12	Stump.value/cord D & up	295 7	3198	3599	4046	4312	4387	423	3890	260				
13	vol.D & up	19.49	1902	1812	1612	1413	1112	846	678					
14	stumpage value D & up	57.50	6080	6520	6520	6160	4880	3580	2640					

<u>price will offer for entire property</u> - buying on scale plus \$3/A for land.

	\$2.957	- stumpage value / cord 6" and up
x	19.49	- volume /A 6" and up
	57.50	= stumpage value /A 6" and up.
+	3.00	= land value / A
	\$60.50	= value\$ /A

\$60.50/A x 1280A = \$77,500 = price to offer owner for entire property in outright purchase when buying ~~a~~ on scale plus \$3/A for land

PREDICTION OF VALUES OF TWO CUT LIQUIDATION

Cut now and again in 15 years

Growth rate of 0.2"/year

DBH	no trees per class	surplus per tree	present surplus D and up	Surplus per class - 1st cut to a - limit							
				8"	9"	10"	11"	12"	13"	14"	15"
6	10.0		$85.44								
7	12.5		87.55								
8	20.0	5.7¢	90.94								
9	14.5	39.5	89.78	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95
10	17.0	78.3	84.06	9.80	9.80	9.80	9.80	9.80	9.80	9.80	9.80
11	12.0	117.5	70.76		23.50	23.50	23.50	23.50	23.50	23.50	23.50
12	6.2	165.5	56.66			24.00	24.00	24.00	24.00	24.00	24.00
13	7.9	211.5	46.40				35.95	35.95	35.95	35.95	35.95
14	2.7	276.3	29.70					33.10	33.10	33.10	33.10
15	2.7	338.0	22.24						20.98	20.98	20.98
16	0.9	411.0	13.13							32.50	32.50
17	0.9	482.0	9.43								13.00
				13.75	37.25	61.25	97.20	130.30	151.28	183.78	196.78

PRESENT VALUE OF TOTAL SURPLUS D AND UP

First cut today, second cut in 15 years

$$Co = \frac{Cn}{1.0p^{n}}$$

Value 8" and up

$\frac{13.75}{1.8009}$ = 7.49
90.94
98.43

Value 10" and up

$\frac{61.25}{1.8009}$ = 34.00
84.06
118.06

Value 11" and up

$\frac{97.20}{1.8009}$ = 54.00
70.76
124.76

Value 12" and up

$\frac{130.30}{1.8009}$ = 72.50
56.66
129.16

Value 13" and up

$\frac{151.28}{1.8009}$ = 84.00
46.40
130.40

Value 14" and up

$\frac{183.78}{1.8009}$ = 101.90
29.70
131.60

Value 15" and up

$\frac{196.78}{1.8009}$ = 109.00
22.24
131.24

PREDICTION OF VALUES OF TWO CUT LIQUIDATION

Cut now and again in 20 years

Growth rate of 0."2/yr.

DBH inches	No trees	surplus tree	present surp. D & up	Total surplus D and up - first cut to A- 8"limit	9"	10"	11"	12"	13"	14"	15"	16"
6	10.0		85.44									
7	12.5		87.55									
8	20.0	5.7¢	90.94									
9	14.5	39.5	89.78									
10	17.0	78.3	84.06	$7.83	7.83	7.83	7.83	7.83	7.83	7.83	7.83	7.83
11	12.0	117.5	70.76	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
12	6.2	165.5	56.66		33.10	33.10	33.10	33.10	33.10	33.10	33.10	33.10
13	7.9	211.5	46.40			30.60	30.60	30.60	30.60	30.60	30.60	30.60
14	2.7	276.3	29.70				47.00	47.00	47.00	47.00	47.00	47.00
15	2.7	338.0	22.24					40.55	40.55	40.55	40.55	40.55
16	0.9	411.0	13.13						25.48	25.48	25.48	25.48
17	0.9	482.0	9.43							38.10	38.10	38.10
18	0.9	565.0	5.09								15.25	15.25
				22.53	55.63	86.23	133.23	173.78	199.26	251.30	252.61	

PRESENT VALUE OF TOTAL SURPLUS D AND UP

First cut today, second cut in 20 years

$$CO = \frac{Cu}{1.0p^{un}}$$

Value 10"

$$\frac{86.23}{2.1911} = \$39.40$$

84.06
123.46

Value 12"

$$\frac{173.78}{2.1911} = \$79.30$$

56.66
135.96

Value 13"

$$\frac{199.26}{2.1911} = \$91.10$$

46.40
137.50

Value 14"

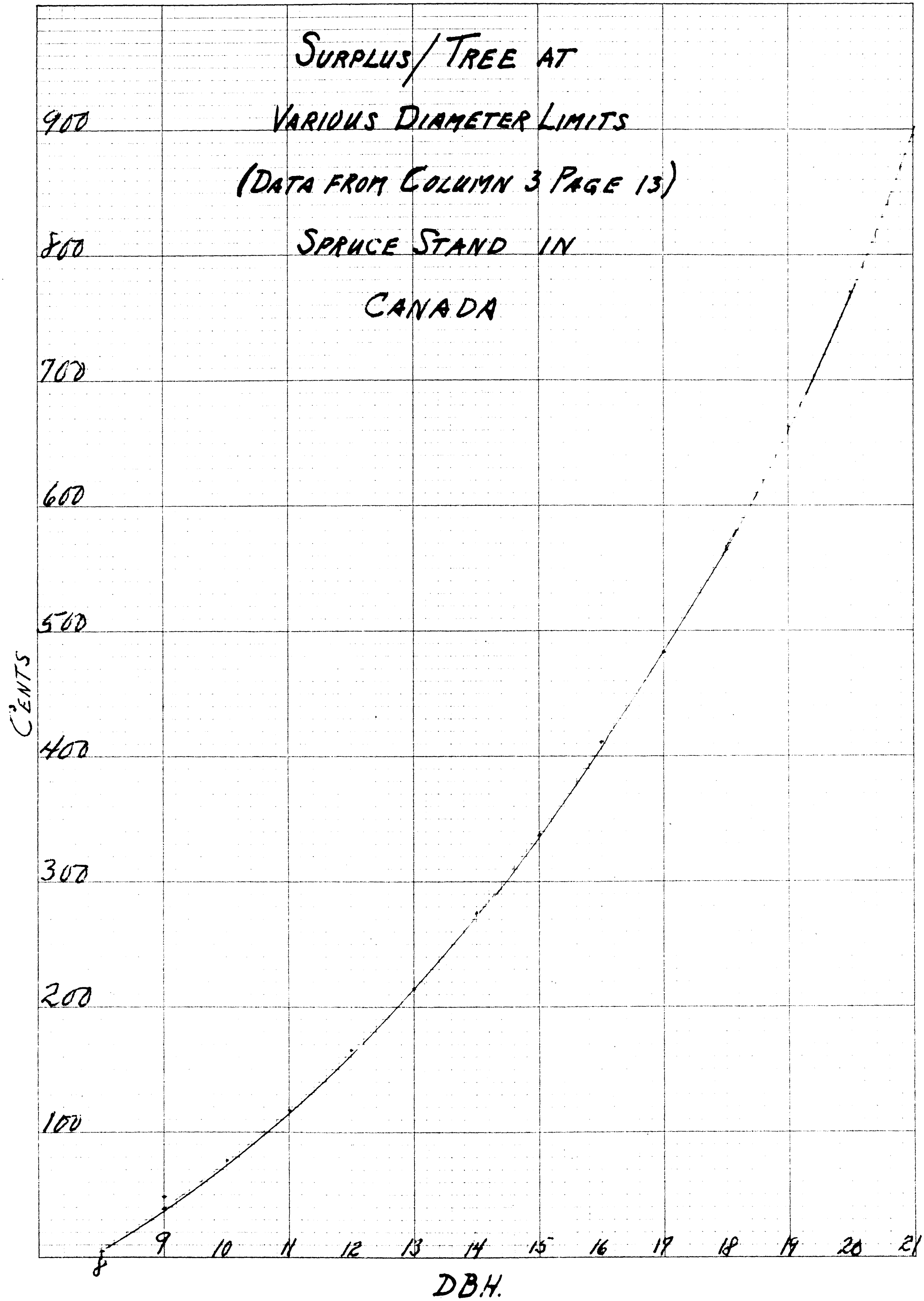
$$\frac{237.36}{2.1911} = 108.20$$

29.70
$137.90

Value 15"

$$\frac{252.61}{2.1911} = 115.50$$

22.24
137.74


SURPLUS/TREE AT
VARIOUS DIAMETER LIMITS
(DATA FROM COLUMN 3 PAGE 13)
SPRUCE STAND IN
CANADA
CENTS
900
800
700
600
500
400
300
200
100
8
9
10
11
12
13
14
15
16
17
18
19
20
21
D.B.H.

PREDICTION OF VALUES OF TWO CUT LIQUIDATION

Cut now and again in 25 years

Growth rate of 0"2/year

DBH	No trees in cl.	surplus tree	pres. surp. D & up	limit 8"	Total surplus D and up - first cut to a- 9"	10"	11"	12"	13"	14"	15"
6	10.00		85.44								
7	12.5		87.55								
8	20.00	5.7	90.94								
9	14.5	39.5	89.78								
10	17.0	78.3	84.06								
11	12.0	117.5	70.76	11.75	11.75	11.75	11.75	11.75	11.75	11.75	11.75
12	6.2	165.5	56.66	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70
13	7.9	211.5	46.40		42.10	42.10	42.10	42.10	42.10	42.10	42.10
14	2.7	276.3	29.70			40.10	40.10	40.10	40.10	40.10	40.10
15	2.7	338.0	22.24				57.50	57.50	57.50	57.50	57.50
16	0.9	411.0	13.13					49.40	49.40	49.40	49.40
17	0.9	482.0	9.43						22.90	22.90	22.90
18	0.9	565.0	5.09							44.60	44.60
19		663.0									17.90
				32.45	74.55	114.65	172.15	221.55	251.45	296.05	313.95

PRESENT VALUE OF TOTAL SURPLUS D AND UP

First cut today, second cut in 25 years

$$Co = \frac{Cn}{1.0p^{xn}}$$

Value 10"

$\frac{114.65}{2.6658}$ = \$42.90
84.06
\$126.96

Value 12"

$\frac{221.55}{2.6658}$ = \$83.00
56.66
\$139.66

Value 13"

$\frac{251.45}{2.6658}$ = \$94.20
46.40
140.60

Value 14"

$\frac{296.05}{2.6658}$ =\$111.00
29.70
\$140.70

Value 15"

$\frac{313.95}{2.6658}$ = \$117.80
22.24
\$140.04

TWO CUT LIQUIDATION - CUT NOW AND AGAIN IN 30 YEARS

Growth rate of 0"2/year

DBH	No. trees in Class	surplus/ tree	pres surp. D & up	8" limit	9"	10"	11"	12"	13"	14"	15"
6	10.0		85.44								
7	12.5		87.55								
8	20.0	5.70	90.94								
9	14.5	39.5	89.78								
10	17.0	78.3	84.06								
11	12.0	117.5	70.76								
12	6.2	165.5	56.66	16.55	16.55	16.55	16.55	16.55	16.55	16.55	16.55
13	7.9	211.5	46.40	26.40	26.40	26.40	26.40	26.40	26.40	26.40	26.40
14	2.7	276.3	29.70		55.40	55.40	55.40	55.40	55.40	55.40	55.40
15	2.7	338.0	22.24			49.00	49.00	49.00	49.00	49.00	49.00
16	0.9	411.0	13.13				69.90	69.90	69.90	69.90	69.90
17	0.9	482.0	9.43					57.80	57.80	57.80	57.80
18	0.9	565.0	5.09						35.00	35.00	35.00
19		663.0								52.40	52.40
20		771.0									20.80
				42.95	98.35	147.35	217.25	275.05	310.05	362.45	383.25

PRESENT VALUE OF TOTAL SURPLUS D AND UP

First cut today, second cut in 30 years

$$Co = \frac{Cu}{1.0p^{n}}$$

__Value 10"__

$$\frac{147.35}{3.2434} = \begin{array}{r} \$45.40 \\ 84.06 \\ \hline \$129.46 \end{array}$$

__Value 12"__

$$\frac{275.05}{3.2434} = \begin{array}{r} \$84.70 \\ 56.66 \\ \hline \$141.36 \end{array}$$

__Value 13"__

$$\frac{310.05}{3.2434} = \begin{array}{r} 95.50 \\ 46.40 \\ \hline \$141.90 \end{array}$$

__Value 14"__

$$\frac{362.45}{3.2434} = \begin{array}{r} \$111.90 \\ 29.70 \\ \hline \$141.60 \end{array}$$

__Value 15"__

$$\frac{383.25}{3.2434} = \begin{array}{r} 118.00 \\ 22.24 \\ \hline 140.24 \end{array}$$

PREDICTION OF VALUES

TWO CUT LIQUIDATION -Cut now and again in 35 yrs

Growth rate of 0."2/yr

DBH	No trees in inches	supr. trees	pres. surp. D & up	Total surplus D and up - firstcut to a - limit 8"	9"	10"	11"	12"	13"	14"	15"
6	10.0		85.44								
7	12.5		87.55								
8	20.0	5.7~~0~~	90.94								
9	14.5	39.5	89.78								
10	17.0	78.3	84.06								
11	12.0	117.5	70.76								
12	6.2	165.5	56.66								
13	7.9	211.5	46.40	21.15	21.15	21.15	21.15	21.15	21.15	21.15	21.15
14	2.7	276.3	29.70	34.60	34.60	34.60	34.60	34.60	34.60	34.60	34.60
15	2.7	338.0	22.24		67.50	67.50	67.50	67.50	67.50	67.50	67.50
16	0.9	411.0	13.13			59.60	59.60	59.60	59.60	59.60	59.60
17	0.9	482.0	9.43				82.00	82.00	82.00	82.00	82.00
18	0.9	565.0	5.09					67.80	67.80	67.80	67.80
19		663.0							41.10	41.10	41.10
20		771.0								60.90	60.90
21		894.0									24.15
				55.75	123.25	182.85	264.00	332.65	373.75	434.65	458.80

PRESENT VALUE OF TOTAL SURPLUS D ANDUP

First cut today, second cut in 35 yrs

$$C_o = \frac{Cu}{1.0p^{n}}$$

<u>Value 10"</u>

$\frac{182.85}{3.946}$ = \$46.30 present value of surp. D & up.coming 35 yrs.from now

<u>84.06 present surplus D & up</u>

\$130.36 present value of total surplus D & up

<u>Value 12"</u>

$\frac{332.65}{3.946}$ = \$84.40
56.66
141.06

<u>Value 13"</u>

$\frac{373.75}{3.946}$ = \$94.60
46.40
\$141.00

<u>Value 14"</u>

$\frac{434.65}{3.946}$ = \$110.00
29.70
\$139.70

Costs of second cut on 30 Yr. cc. First cut to a 12" dbh.

Volume of second cut:

DBH	No.trees	Vol. cords/tree	total vol./class in cords
12	10.0	.270	2.70
13	12.5	.331	4.14
14	20.0	.405	8.10
15	14.5	.481	6.97
16	17.0	.562	9.56
17	12.0	.657	7.89
			39.36 cords

Variable skid cost = 4.1¢/cord/sta

$$S = \sqrt{\frac{17.4 \times 1000}{39.36 \times 4.1}} = \sqrt{\frac{17,400}{161.2}} = \sqrt{107.9} = 10.4 \text{ sta.}$$

Trial calc. with slacker spacing at 12-1/2% of road spacing

$$2PCS = 2 \times 0.2525 \times 4.1 \times 10.4 = 21.6$$

$$\frac{L}{0.02875\ S^2V} \quad \frac{5000}{0.0287 \times 107.9 \times 39.36} = 32.9$$

$$\frac{21.6}{32.9} = 0.656 : 1 \quad \therefore Z = 80\%$$

$$S = \sqrt{\frac{13.0 \times 1000}{39.36 \times 4.1}} = \sqrt{\frac{13,000}{161.2}} = \sqrt{80.6} = 9 \text{ sta.}$$

Cost

Hence put 1 extra road in area, cutting present spacing in half or 10.2 sta.

$$2PCS = 2 \times 0.336 \times 4.1 \times 10.2 = 24.8$$

$$\frac{L}{0.1835S^2V} \quad \frac{5000}{0.183 \times 100.4 \times 39.36} = \frac{7.2}{32.0¢}$$ / cord moved to new roads.

Costs

skidding = 0.289 SC = 0.289 x 10.2 x 4.1 = 12.1

road maintenance = $\frac{R/121}{V\ C}$ = $\frac{20000}{\frac{12.1}{39.36 \times 4.1}}$ = $\frac{1652.0}{161.2}$ = 10.3

slasher moving = 8.6

31.0¢/cord

when moved to reconditioned old roads

31.0¢ /cord

320/cord

2/630

31.5¢/cord=avg.variable skidding cost

cost of maintenance on main road

\$200/mi x 10 mi = $\frac{200,000¢}{50,400 \text{ cords}}$ = 3.97 or 4¢/cord

31.5

4.0

35.5¢ / cord = total class "C" costs

Actual road and skidding costs for second cut:

With effective road spacing at 26.4 stations:

cost of road = 10.3

skidding - 0.289SC = 0.289x26.4x4.1 = 31.2

slasher moving = $\frac{5000}{0.138 \times 100.4 \times 39.36}$ = 7.2

48.7 x 1/4 of vol. = 12.2¢

With effective road spacing at 13.2 stations

new road:

2PCS = 2x0.336x4.1x13.2 = 36.4

$\frac{LX}{0.1835S\ V}$ = $\frac{5000}{0.183 \times 100.4 \times 39.36}$ = 7.2

43.6 x 1/4 of volume = 10.3

old road:

skidding: 0.289SC = 0.289 x 13.2 x 4.1 = 15.6

road maintenance = $\frac{R/12.1}{VC}$ = $\frac{\frac{20000}{12.1}}{39.36 \times 4.1}$ = 10.3

Slasher moving 8.6

34.5 x 1/2 of volume = 17.3

39.8/cord

Total Class "C" cost:

39.8¢
+ 4.0
43.8¢/cord

Present Worth of Property as 12" - 30 year plan.

$$PW = \left(S - FPA\right) + \left(\frac{S_2 - FPA_2}{1.0P^{cc}}\right) - T\left(\frac{1.0P^{cc} - 1}{.0P \times 1.0P^{cc}}\right) + \frac{Ss}{1.0\,P^{cc}}$$

$$= (\$56.66 - \$20;80) + \left(\frac{\$275.05 - \$17.20}{3.2434}\right) - \$0.156\left(\frac{3.2434 - 1}{.04 \times 3.2434}\right) + \frac{\$3.00}{3.2434}$$

$$= \$35.86 + \frac{\$257.85}{3.2434} - \$0.156\,(17.2920) + \$0.925$$

$$= 35.86 + 79.40 - 2.695 + 0.925$$

= $113.48/A = present value of property on a two cut liquidating plan, first cut now to a 12" diameter limit and second cut in 30 years.

= $113.48/A x 1280A = $145,000 = present value of entire property