Using FPInterface to Estimate Availability of Forest-Origin Biomass in British Columbia: Kamloops TSA

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Abstract

Based on inventory information and a 20-year harvest queue, estimates of the amount of biomass available from forest harvest residues are estimated in $10 increments of delivered cost. For the Kamloops Timber Supply Area, 118,000 odt/year is projected to be available at $60/odt.

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1. Executive summary

In 2011 FPInnovations used FPInterface to develop and demonstrate a method for estimating available forest-origin biomass in British Columbia's Timber Supply Areas (TSA): the test case was the Quesnel TSA. The method was subsequently refined and applied to the Williams Lake TSA (2012); the Prince George TSA (2012); the Lakes TSA (2012); the Mackenzie TSA (2013); the 100 Mile House TSA (2014); and the Kamloops TSA (2016), for which the results are reported here. The biomass inventory was based on 20-year harvest and road network plans for Crown land (excluding Woodlot Licenses, Tree Farm Licenses, Community Forest Agreements, and First Nations tenures) provided by the British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO).

The projected biomass yield derived from harvest residues in the Kamloops TSA is 21.8 oven-dried tonne (ODT)/ha.

The biomass ratio (the ratio of recovered biomass to recovered merchantable roundwood) is estimated at 21.1%. Over the 20-year harvest horizon a total of 4.90 million ODT of available biomass, or approximately 245 000 ODT/year, are predicted to be derived from harvest residues in the Kamloops TSA. Of this, a total of approximately 2.35 million ODT in total, or 118 000 ODT/year, are expected to be available at the economic price of $60/ODT. Nearly all of the total predicted volume is expected to be available at $90/ODT, i.e., a total of 4.59 million ODT, or 230 000 ODT/year.

A low-cost grinding scenario was run, in which the grinding cost was reduced by $4.76/ODT. When the cost of biomass is at the economic rate of $60/ODT, the lower-cost grinding increased biomass availability by approximately 600 000 ODT over 20 years, or by about 30 000 ODT/year. I.e., if efficiencies or lowered costs can be realized, available biomass could increase.

Of the biomass that is considered economically available (≤$60/ODT), most of it is located near the city of Kamloops. The amount of economically available biomass decreases over the 20-year harvest horizon. While fewer harvest blocks are planned in later years, the scale of the decrease indicates that as time passes, more blocks are located further from Kamloops.

2. Introduction

In order to progress toward full implementation of a bioeconomy in British Columbia a key piece of information is needed—i.e., a detailed inventory of economically available biomass.

To address this need, in 2011 FPInnovations undertook a project in partnership with the Inventory Branch of the British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO). The specific goals of the project were to develop a process for calculating biomass inventories in British Columbia's Timber Supply Areas (TSAs) in the Central Interior. The projections of biomass availability were based on 20-year harvest and road network plans for Crown land (excluding Woodlot Licenses, Tree Farm Licenses, Community Forest agreements, and First Nations tenures) provided by the MFLNRO.

In 2011 FPInnovations developed and demonstrated a method for estimating and projecting available forest-origin biomass in TSAs, using FPInterface: the test case was the Quesnel TSA (Friesen &

Goodison, 2011). This method was subsequently refined and applied to the Williams Lake TSA (Friesen, 2012a), the Prince George TSA (Friesen, 2012b), the Lakes TSA (Friesen, 2012c), the Mackenzie TSA (Friesen, 2013), and the 100 Mile House TSA (Friesen, 2014). An analysis of the Kamloops TSA was run in 2014, for which the outcomes are reported here. The aim in providing the projections is to help decision makers better understand biomass availability when preparing industrial proposals.

Detailed introductory statements describing the background and rationale of this project and the greater project as a whole are in Friesen & Goodison (2011).

3. Objective

As abridged from the report about the Quesnel TSA (Friesen & Goodison, 2011) the objectives for the Kamloops TSA biomass analysis were:

Calculate biomass supply for volume-based tenures in the Kamloops TSA. Specific deliverables include:

a. An analysis showing the delivered cost of biomass from point of origin
b. An analysis showing the amount of biomass delivered at different price points—A value of $60 per oven-dried tonne (ODT) was set as the agreed-upon threshold at which to determine commercial biomass availability, in accordance with the previous analyses.

4. Methods

Overall process

The basic methodology for determining biomass supply in western Canada was established during analyses of the Quesnel TSA (Friesen & Goodison, 2011) and the Williams Lake TSA (Friesen, 2012a). It is reviewed below.

The analysis focused on the Kamloops TSA and was based on polygon data (tree characteristics) and a road data set supplied by the MFLNRO. It did not include any nearby woodlots, Community Forest Agreements, or any First Nations tenures. Including some of these areas would have altered the available supply of biomass.

Additionally, stands considered unmerchantable due to small stem size were not included in the analysis. The analysis focused on recovering harvest residues from merchantable stands. Purposely harvesting unmerchantable stands for biomass could add to the biomass supply and further analysis could be undertaken to determine its profitability. Recent analysis has shown that harvesting these stands is not yet profitable.

The process map in Figure 1 graphically displays the steps taken to build the final inventory of economically available biomass for the Quesnel TSA. A similar process was used for this analysis of the Kamloops TSA.

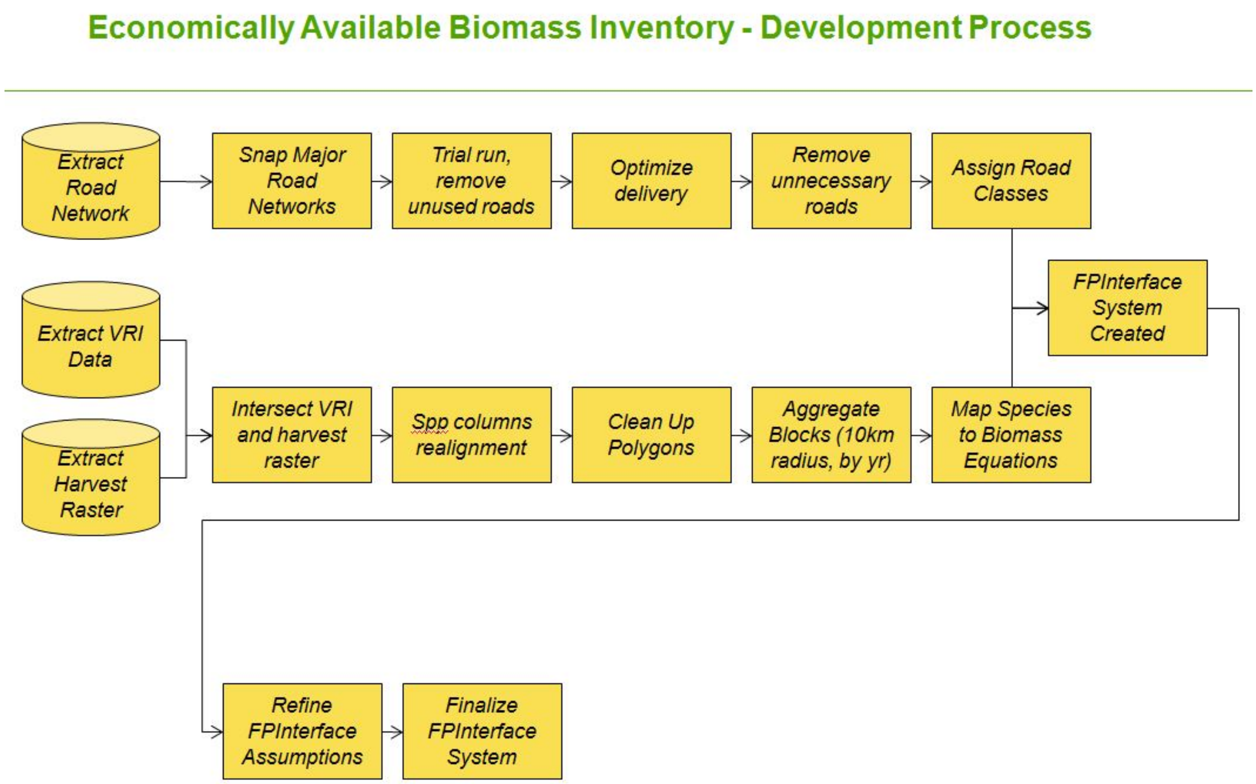

Figure 1. Steps taken to build the final inventory of economically available biomass.

Data acquisition

Data layers for the Kamloops TSA (excluding woodlots, CFA area, and any First Nations tenure areas) were acquired from the MFLNRO. The data included Vegetation Resource Inventory polygons with attributes, and road linework with attributes. The polygon data covered 20 years of harvest over four consecutive 5-year periods.

The total 20-year harvest raster is a point-in-time snapshot. It indicates which polygons are expected to be harvested over the 20 years. No attempt was made to model possible growth or mortality during the 20-year horizon. Any projections of growth or mortality are already accounted for in the harvestable proportion contained in the harvest raster data.

Data transformation

FPInterface requires two major inputs—a polygon layer of harvestable blocks with attributes, and a road layer. The polygon layer must also have a harvest raster built into it, indicating which polygons are to be harvested in which time period. To calculate biomass amounts, FPInterface requires both tree size data (or height and dbh) and either stand density (stems per ha) or volume per ha by species in each polygon. When the polygon layer is uploaded it is necessary to tie species in the resultant to the species present in FPInterface.

In order to speed up the calculation, polygons with little or no merchantable volume were targeted for elimination. Polygons with no volume were removed from the resultant. Some of these polygons resulted from the process of intersecting the VRI and the harvest raster layers. Aggregation rules meant blocks were grouped if they had the identical harvest year and were within a 10-km radius.

FPInterface calculates cost in part by finding a transport route from the product origin in a polygon (block) to the mill or delivery site. It relies on a continuous path along the road network. If digital road segments are not joined together (snapped), the program is not able to find a path between the block and the mill, or it may find a sub-optimal circuitous path.

Examination of the data set showed that road snapping was required. A program was used to identify gaps in the road network and close them. A few polygons were still inaccessible after snapping, but these represent far less than 1% of the total area, so it was deemed not worthwhile to find the remaining gaps manually.

Biomass equations

To perform the analysis, tree species indicated in the inventory are tied to single-tree biomass equations in FPInterface. These equations were based on "Canadian national tree above ground biomass equations". Although this equation set includes trees from all across Canada, including western and northern Canada, there were very few samples from British Columbia. More recently, Lambert et al. (2005) and Ung et al. (2008) have released tree equations for British Columbia (accepted by the MFLNRO) and these were incorporated into FPInterface for all the analyses performed after the initial one (Quesnel TSA).

FPInterface parameters

Tree species associations

Species associations were made as shown in Table 1.

Table 1. Tree species associations

FPInterface species	System label	Named	Original dataset
Fir, alpine	B	Abies	B
Cedar, western red	C	western redcedar	C
Douglas-fir (Interior)	F	Douglas-fir	F
Hemlock, western	H	hemlock	H
Larch, western	L	larch	L
Aspen, trembling	O	deciduous	O
Pine, lodgepole	P	lodgepole pine	P
Oak, white	Q	oak	Q
Spruce, white	S	spruce	S
--	-	(excluded)	X

Road classes

Unlike the dataset used in the analysis of the Quesnel TSA (Friesen & Goodison, 2011), no road classes were contained in the road data set. However, FPInterface has the ability to assign road classes based on the amount of volume hauled over each section of road. The volume hauled is for merchantable volume as calculated by FPInterface. The volume and speeds associated with each road class were assigned as listed in Table 2.

Table 2. Road class associations

FPInterface road class	Volume		Road speed		
	Minimum (m^3)	Maximum (m^3)	Posted speed (km/h)	Empty haul[a] (km/h)	Loaded haul [b] (km/h)
Paved	10 000 001	50 000 000	90	86	77
Class 1 (off highway)	0	0	70	67	60
Class 1	2 000 001	10 000 000	70	67	60
Class 2	1 000 001	2 000 000	50	48	43
Class 3	500 001	1 000 000	40	38	34
Class 4	5 001	500 000	20	19	17
Class 4 (operational)	0	0	20	19	17
Class 5 (winter)	0	5 000	20	19	17

[a] 95% of posted speed. [b] 85% of posted speed.

General parameters

The price of fuel can have significant impacts on model results. Some equipment in the model can use diesel while other equipment is eligible for marked fuel. A price of $1.00/L was assigned, which was slightly higher than current rates for diesel but approximates a medium-term average. Additionally, another scenario was run in which fuel was priced at $0.75/L, to more closely mimic current conditions. And a further scenario using $1.25/L was run to explore that eventuality.

The model's default values for productivities and costs of forestry equipment rely on a long history of FPInnovations studies and other information gathered by FPInnovations. If users have specific values or costs they wish to apply to any phase or machine, these can be used instead of the defaults. For this project, only the default values were used. To verify their suitability the default values were compared with machine costs listed in the *Interior Appraisal Manual* and were found to be close approximates.

Based on a terrain classification system developed by the Canadian Pulp and Paper Association (CPPA) (Mellgren, 1980), average slope for the area was assigned to CPPA Class 3 (20 to 32%). Ground strength was rated as CPPA Class 3 (moderate), and ground roughness was rated as CPPA Class 3 (uneven).

Comminution cost

Working time for British Columbia conditions was based on previous base case studies, consisting of one 12-hour shift/day, 200 days/year. Grinder utilization was set at 60% and the amount of fuel used per productive machine-hour for the grinder was the standard 135 L/PMH. These are the standard base case parameters used in past FPInnovations studies and are included to enable ease of comparison to those studies. In this study, these parameters produced a grinding cost of $25.89/ODT.

However, recent developments in the industry have led to lower grinding costs, so these parameters were changed to create a low-cost grinding scenario with 75% efficiency and fuel use of 100 L/PMH, in order to represent the new conditions. This produced a grinding cost of $21.23/ODT, which was thought to be achievable by an experienced operator in the conditions of the Kamloops TSA.

Topping diameter

Although British Columbia regulations require a topping diameter of 10 cm for most merchantable species, this analysis used 12.5 cm in order to reflect more common industrial practise. Topping diameter can have a significant impact on the volume of a tree available for biomass use.

Utilization of lodgepole pine and mountain pine beetle-attacked wood: considerations

In the previous studies of TSAs in this series (Friesen & Goodison, 2011; Friesen, 2012a, 2012b, 2012c, 2013), mortality of lodgepole pine due to infestation by mountain pine beetle was a significant factor in timber supply modelling. Because the beetle has now basically “run its course” in the Interior of British Columbia, it was not deemed necessary for the calculation to attribute future additional fibre to the effects of mountain pine beetle infestation. Previous studies discounted 30% of lodgepole pine stems from sawlogs and used half of these (15% of total lodgepole pine) for biomass. Five years on from the Quesnel study it is believed that the MFLNRO timber supply calculation adequately accounts for lodgepole pine mortality. Further, deterioration and downing of dead lodgepole pine has increased significantly since the first analysis of biomass availability was performed (for the Quesnel TSA in 2011), making much of it unattractive for potential biomass uses. For this study, all available lodgepole pine stems were attributed to sawlogs, i.e., the same as other species.

Parameters as entered into FPInterface

Table 3 presents a summary of some of the parameters for the base case, as entered into FPInterface, which produces a grinding cost of $25.89/ODT. A low-cost grinding scenario was also attempted, which produced a grinding cost of $21.23/ODT.

Table 3. FPInterface parameters: base case

Run descriptor	Base case – default grinding efficiency
run name	Kamloops
output name	Biomass - Kamloops
block system	biomass_blocks20.shp
road system	Roads_KamloopsTSA.shp
transfer yard(s)	Domtar mill
cost per transfer yard, respectively	0
year(s) analyzed	All
species attribute linking	BC
automatic assignment of road class by volume	Yes
road maintenance	Yes
haul speeds	Graduated
haul speeds at 95% / 85% of posted	Yes
transport shifts / day	1
transport hours / shift	12
transport days / year	200
transport fuel price / litre	$1.00
ground strength	3 – moderate
ground roughness	3 – uneven
average slope (%)	20-32
slash used for biomass	Yes
full stem used for biomass	No
chips destination	Domtar mill
topping diameter (cm)	12.5
truck used for chips	3-axle
truck used for logs	Tridem B-train
harvesting fuel price / litre (x3)	$1.00
harvesting shifts / day (x3)	1
harvesting hours / shift (x3)	12
harvesting days / yr (x3)	200
harvesting system	full tree with roadside processing
felling & processing	mechanized and bunched
skid type	skidder with grapple
type of roadside processing	cut-to-length
on site biomass treatment (roadside)	comminution
recovery season	Winter
slash freshness	>3 months
slash pre-piled at roadside	Yes
grinder size type	horizontal 600 kW
biomass fuel price / litre (x2)	$1.00
biomass hours / shift (x2)	12
biomass shifts / day (x2)	1
biomass days / yr (x2)	200
grinder efficiency (%)	60
grinder fuel use (L/PMH)	135
indirect costs - biomass ($ value)	$0.00
indirect costs - harvesting ($ value)	$0.00

For the low-cost grinding scenario the parameters highlighted in yellow were adjusted to 75% and 100 L/PMH.

Delivery locations

All harvest residues from in-woods operations (not from mills) were directed to the Domtar mill in Kamloops for processing. Initial comminution was set to take place at roadside, and costs were calculated for biomass delivered to the mill.

Biomass calculations

The biomass calculations in FPInterface produce a volume of total available biomass once merchantable roundwood has been removed. For this project, only biomass transported to roadside was considered recoverable, and biomass likely to remain at the stump or dispersed on the cutblock was not. Once it is transported to roadside, some biomass becomes unavailable due to handling and technical losses. The remainder is considered recovered biomass. Figure 2 shows this breakdown with the numbers from the 20-year harvest of the base case (normal grinder utilization of 60% and fuel usage of 135 L/PMH).

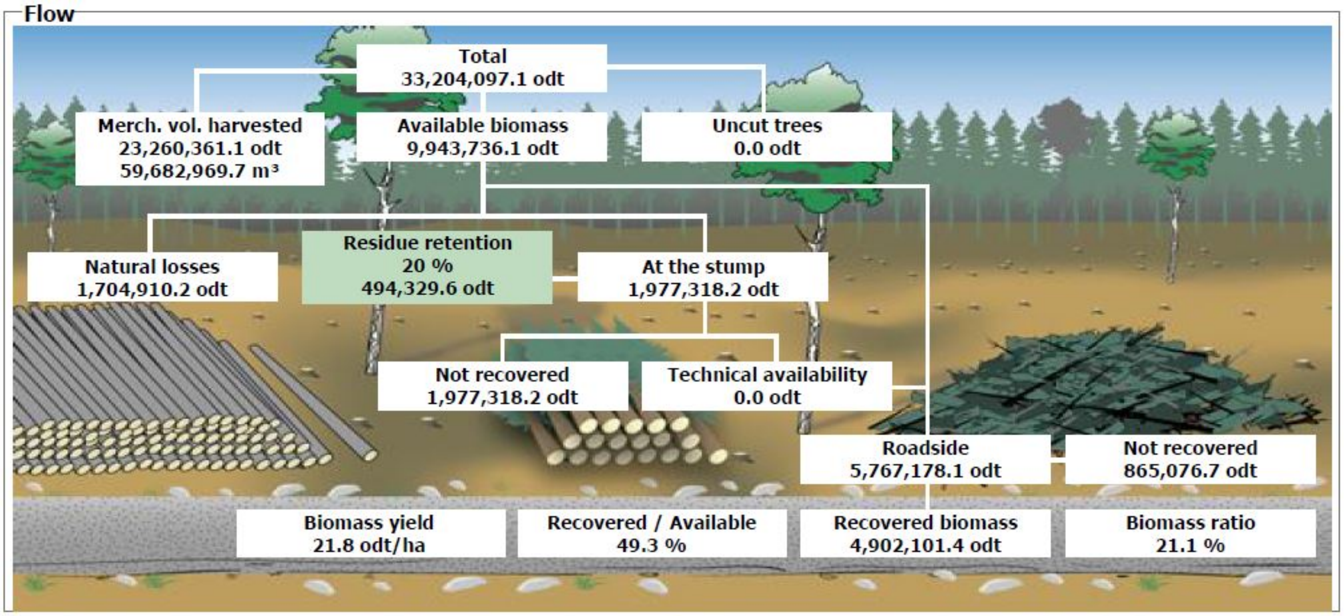

Figure 2. Recoverable biomass in the Kamloops TSA, delivered to the Kamloops mill: base case.

5. Results and discussion

Summary—key results

All results from the different runs performed in FPInterface are summarized in Appendix 1. The FPInterface analysis of biomass supply in the Kamloops TSA with delivery to the mill in Kamloops, based on inventory information and the road network supplied by the MFLNRO, indicates an average biomass yield of 21.8 ODT/h for the base case. This is in the form of comminuted hog fuel and comes from harvest residues only, i.e., tops, branches, and other roadside logging waste. Mill residues are not predicted by the model. The biomass yield for the Kamloops TSA is 21.8 ODT/ha.

Biomass amounts

In total, for the base case (normal grinder utilization of 60% and fuel usage of 135 L/PMH), the model predicted 4 902 101 ODT can be recovered from roadside and delivered to the Kamloops mill site over the course of the 20-year harvest horizon. The amount of biomass available in each 5-year period is spread reasonably evenly through time and works out to approximately 245 000 ODT of biomass per year, at any price point in the study area. (The economically available volume is estimated at 118 000 ODT/year, as described below.) Key amounts of biomass availability are presented in Table 4.

Additionally, the model indicates that there are about 4 177 000 ODT of biomass that would be left on the cutblock and would not make it to roadside. This is nearly as much (85%) as the amount removed for biomass and includes material that falls off trees naturally and material that breaks off the stems and is left on the ground during normal harvesting operations. This vast amount of material retained in the forest is much higher than that deemed necessary for replenishing the forest floor and preventing nutrient degradation to the soil. Additionally, 865 000 ODT of biomass material that makes it to roadside is not recovered due to technical handling efficiencies, that is, the material is too small or too large for conventional machine handling or is not physically positioned for economic accessibility.

Table 4. Availability of biomass in the Kamloops TSA, by cost per ODT: key amounts

Biomass Available (odt)		
at $60/odt	at $90/odt	total ($130/odt)
2,352,193	4,592,927	4,902,101
per year	per year	per year
117,610	229,646	245,105

Biomass ratio

The biomass ratio (BR) (the ratio of recovered biomass to recovered merchantable roundwood)is 21.1% for the base case (Table 5). The model predicted 23 260 361 ODT of roundwood and 4 902 101 ODT of biomass.

Knowing the biomass ratio for an area can be useful in making rough predictions of the amount of available harvest residue if the amount of merchantable timber harvest is known.

Table 5. Calculation of biomass ratio

Biomass Ratio	
4,902,101	odt of biomass
23,260,361	odt of roundwood
= 21.1 %	

Cost availability

FPInterface conveniently breaks down the available supply into delivered cost by $10 increments. At the presumed market rate of $60/ODT, the amount available over 20 years is predicted to be 2 352 193 ODT or about 118 000 ODT/year. The complete results, in $10 increments for the entire 20-year harvest period, are presented in Table 6 and Figure 3. The amounts are cumulative. So the amount available at $60/ODT, for example, includes all the biomass at $50/ODT and the additional biomass available between $50 and $60/ODT.

Table 6. Cost availability of biomass in the Kamloops TSA: base case

Base Case	Normal grinder utilization	
Cost $/odt	Odt Available	Odt/year
$10	-	-
$20	-	-
$30	598.1	29.9
$40	27,374.8	1,368.7
$50	836,377.3	41,818.9
$60	2,352,192.9	117,609.6
$70	3,380,868.5	169,043.4
$80	4,249,799.2	212,490.0
$90	4,592,927.3	229,646.4
$100	4,784,494.2	239,224.7
$110	4,874,581.1	243,729.1
$120	4,897,403.0	244,870.2
$130	4,902,101.4	245,105.1

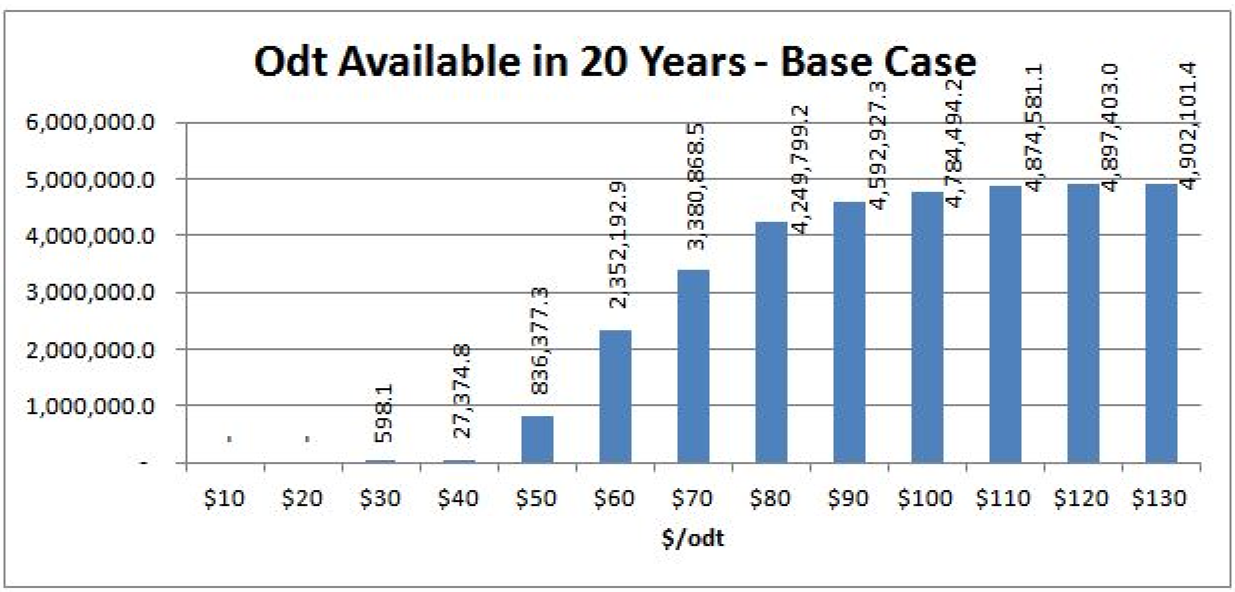

Figure 3. Cost availability of biomass in the Kamloops TSA: base case.

Low price scenario

In addition to the base case, for which the grinding cost was $25.89/ODT, a scenario with a lower grinding cost, i.e., $21.23/ODT ($4.76 below the base case), was also examined. Although this was achieved by manipulating the grinder utilization and fuel consumption, it could represent increased operational efficiency or a lower fuel price, for example. The changes in operating cost changed the radius of economically accessible biomass, and produced the results in Table 7 and Figure 4. The results are also graphically presented in Figure 4.

The lowering of grinding costs by $4.76/ODT produced some startling differences in availability. At $60/ODT, a total of nearly 600 000 more ODT are associated with the lower grinding cost. This equates to nearly 30,000 more ODT per year. This difference at $60/ODT, the presumed market rate for biomass, is highlighted in Figure 5.

This means that much more biomass is available when fuel costs are lower. The actual difference in cost per delivered tonne of biomass is less than $5, but the impact this has on availability is much greater because of the spatial distribution of biomass. The average price for delivered biomass across the Kamloops TSA is shown in Table 8.

In this case, the difference in delivered costs has been created by changes to grinder utilization and fuel consumption. However, differences to delivered costs can also be created by changes to equipment or practises that raise or lower operating costs. Thus, if greater efficiency in grinding technology is realized, it can dramatically increase the amount of biomass that is economically available, especially at the lower price points. This is the message of Figure 5.

Table 7. Cost availability of biomass in the Kamloops TSA: comparison of the base case and the low-cost grinding scenario

Base Case	Normal grinder utilization		Scenario - lower costs by $4.75/odt	
Cost $/odt	Odt Available	Odt/year	Odt Available	Odt Available
$10	-	-	-	-
$20	-	-	-	-
$30	598.1	29.9	1,006.3	50.3
$40	27,374.8	1,368.7	309,567.8	15,478.4
$50	836,377.3	41,818.9	1,584,738.9	79,236.9
$60	2,352,192.9	117,609.6	2,938,025.7	146,901.3
$70	3,380,868.5	169,043.4	3,810,608.7	190,530.4
$80	4,249,799.2	212,490.0	4,469,479.2	223,474.0
$90	4,592,927.3	229,646.4	4,691,152.8	234,557.6
$100	4,784,494.2	239,224.7	4,839,992.9	241,999.6
$110	4,874,581.1	243,729.1	4,890,902.6	244,545.1
$120	4,897,403.0	244,870.2	4,902,101.4	245,105.1
$130	4,902,101.4	245,105.1	-	-

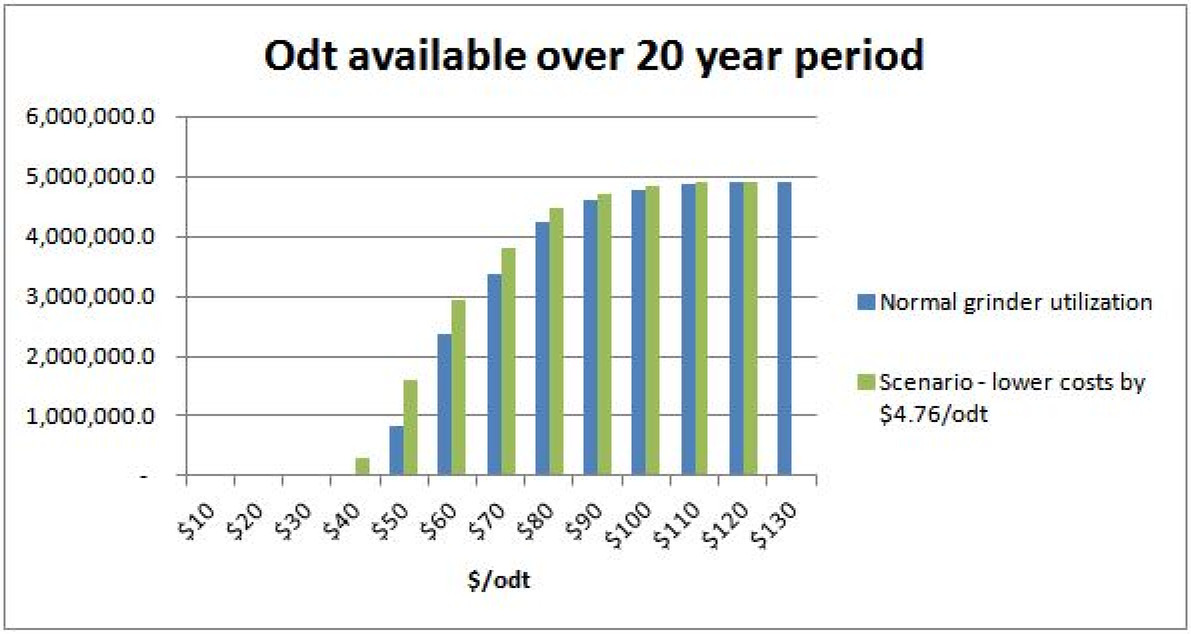

Figure 4. Cost availability of biomass in the Kamloops TSA: comparison of the base case and the low-cost grinding scenario.

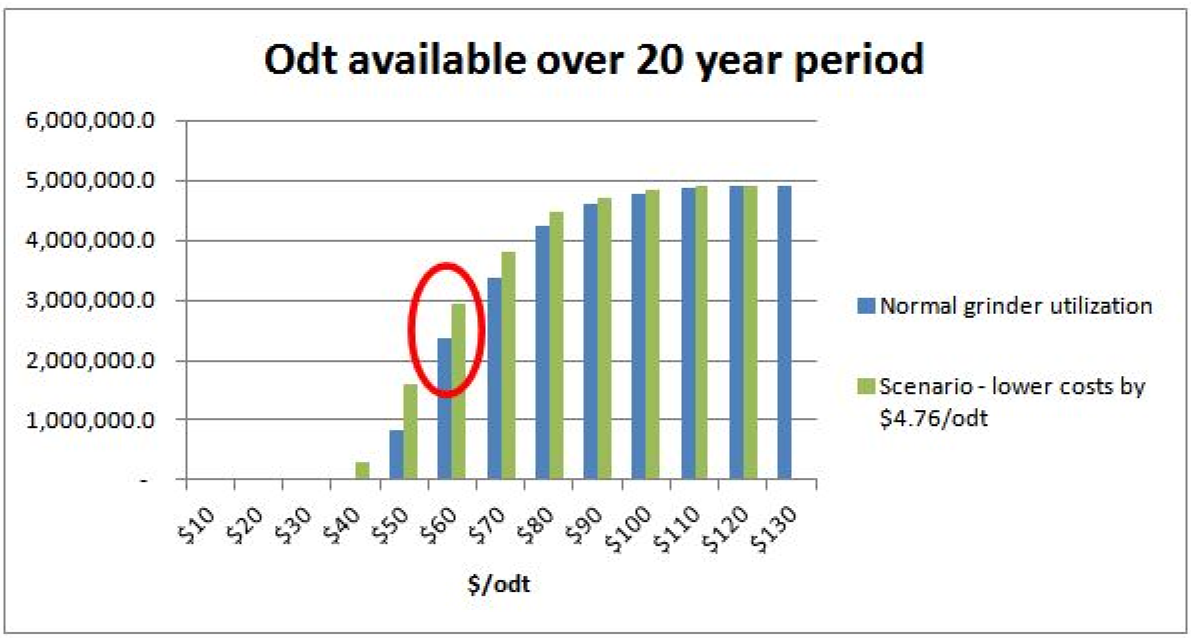

Figure 5. Cost availability of biomass in the Kamloops TSA: comparison of the base case and the low-cost grinding scenario, with difference at $60/ODT highlighted.

Table 8. Average cost of delivered biomass across the entire Kamloops TSA

Fuel price	Average cost of delivered biomass ($/ODT)
Base case – grinding at $25.89/ODT	63.61
Scenario – low-cost grinding at $21.23/ODT	58.94

Mapping

The distribution of costs by cutblock is shown graphically in FPInterface with a colour scale ranging from lime to pink, as in Figure 6. The costs range up to $85/ODT for the blocks farthest from the delivery point.

Showing the roads on the map makes it a little more difficult to distinguish the blocks (Figure 7). The different colours associated with the roads represent different classes of roads. Each road class has a unique set of speed associations for loaded and empty trucks that help determine the cycle times used to calculate the delivery cost for biomass. Road class is determined by the amount of harvest that passes over the road.

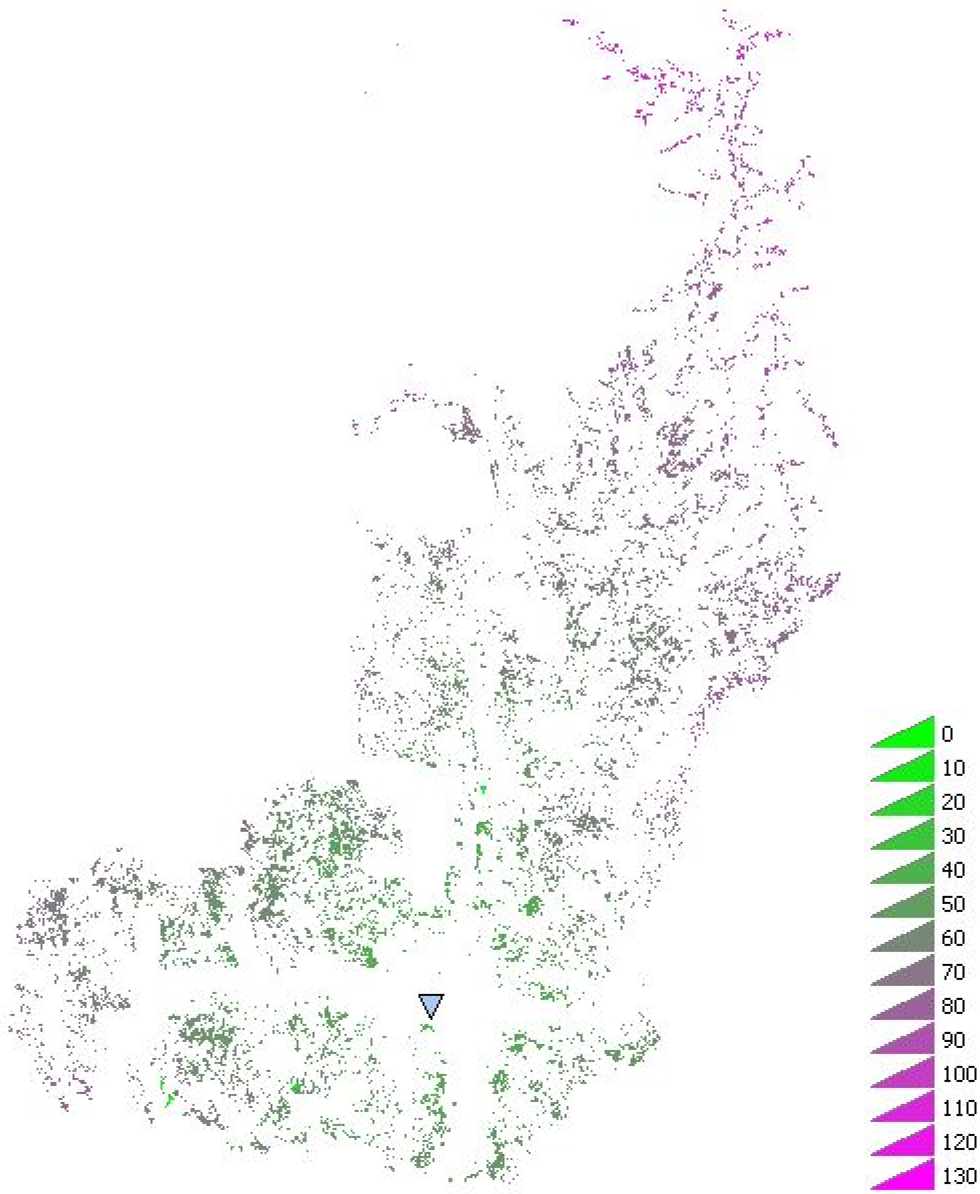

Figure 6. Cost of delivered biomass from point of origin to the Domtar mill in Kamloops, with no roads, in increments $10/ODT. The colour scale represents the estimated cost ($/ODT) of delivered biomass from that block. Blocks with the lowest delivered costs are the greenest in colour. The most expensive blocks are pink/violet in colour. The delivery point (Domtar mill in Kamloops) is represented by the mill icon (blue triangle) in the lower right of the map.

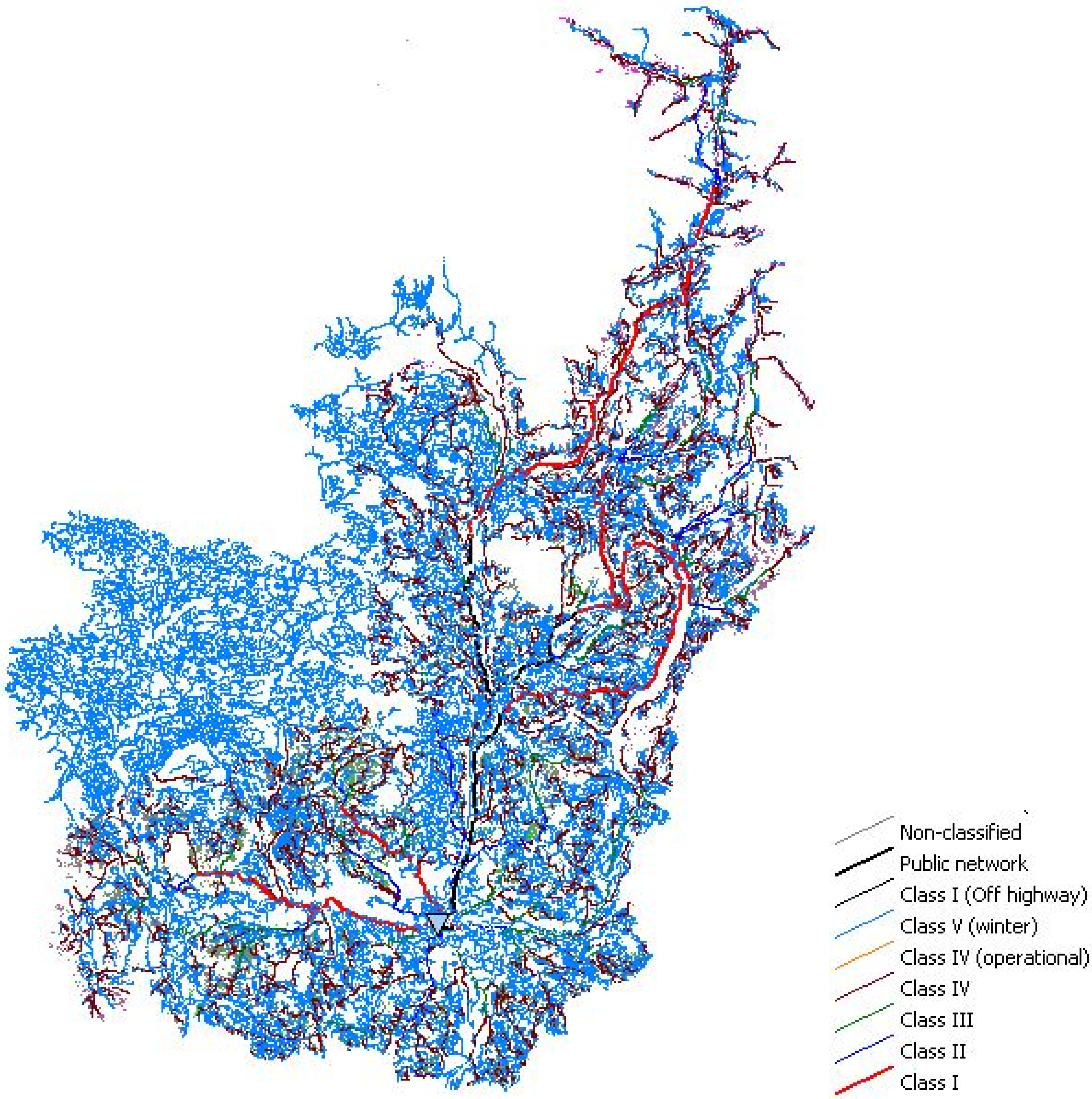

Figure 7. Cost of delivered biomass from point of origin to the Domtar mill in Kamloops, with roads, in increments of $10/ODT. Blocks with the lowest delivered costs are the greenest in colour. The most expensive blocks are violet in colour. Most of the slowest roads are in blue, while the fastest ones are red and black.

Temporal distribution of harvest

The harvest dataset contains a temporal period assigned to each cutblock. There are four consecutive periods in the data, each representing 5-years.

The harvest projection showed only a slight variation among the harvest periods, with a slight falldown toward period three (Years 11 to 15), as shown in Figure 8. Possibly this is explained by reduced harvest due to mountain pine beetle-affected trees becoming unavailable, or the falldown may merely reflect a lack of data about planned harvest in the latter periods.

Looking at the economic harvest available (i.e., the available amount of biomass at $60/ODT, Figure 9), there is a disproportionate decline (compared to Figure 8) in the last two periods. This indicates that the blocks tend to be further from the delivery point (mill) in the last two periods.

The data for cost availability by 5-year period at all price points in increments of $10 are shown in Tables 9 and 10 for both the base case and the low-cost grinding scenario.

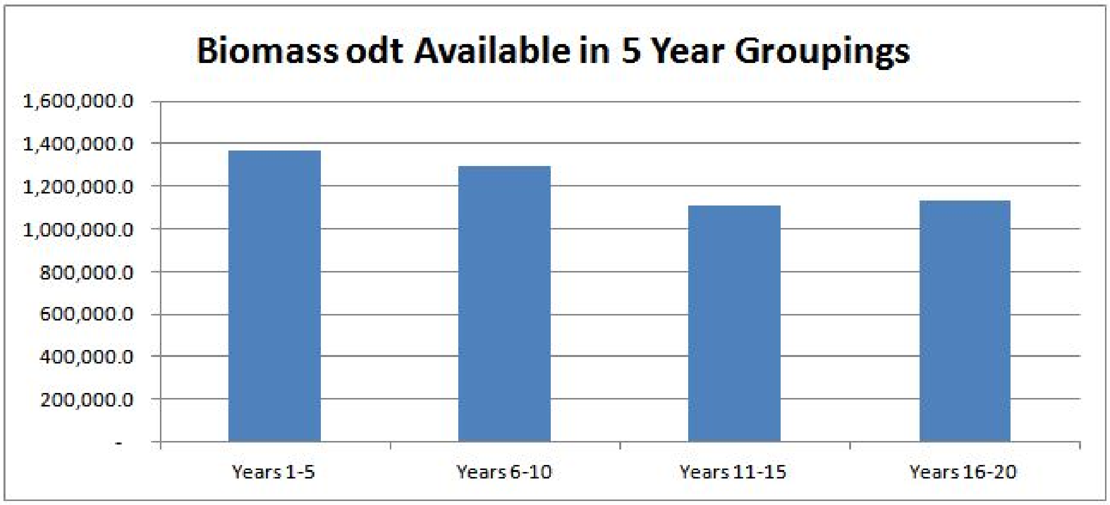

Figure 8. Availability of biomass in the Kamloops TSA, by 5-year harvest period.

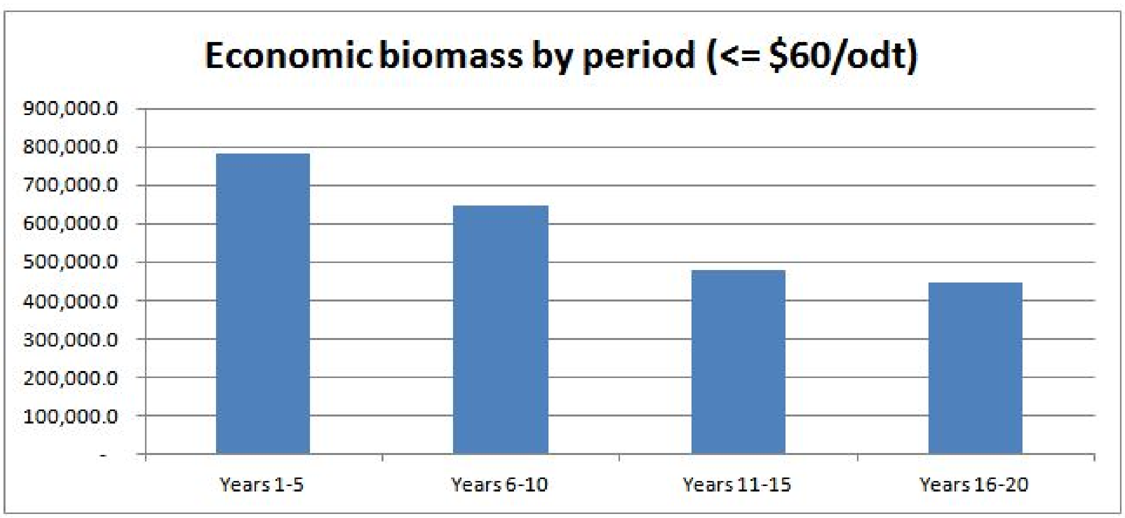

Figure 9. Availability of biomass in the Kamloops TSA, by 5-year harvest period, at ≤$60/ODT.

Table 9. Cost availability of biomass in the Kamloops TSA, by 5-year period: base case

Base Case	Period 1 - years 1-5		Period 2 - years 6-10		Period 3 - years 11-15		Period 4 - years 16-20	
Cost $/odt	Odt Available	Odt/year	Odt Available	Odt/year	Odt Available	Odt/year	Odt Available	Odt/year
$10	-	-	-	-			-	-
$20	-	-	-	-			-	-
$30	-	-	-	-			-	-
$40	7,318.5	731.9	9,885.3	1,977.1	6,612.4	1,322.5	3,558.6	711.7
$50	255,720.4	25,572.0	249,843.8	49,968.8	182,986.9	36,597.4	147,826.3	29,565.3
$60	781,442.8	78,144.3	646,570.9	129,314.2	476,603.1	95,320.6	447,576.2	89,515.2
$70	1,059,179.4	105,917.9	911,939.4	182,387.9	724,331.6	144,866.3	685,418.2	137,083.6
$80	1,311,161.6	131,116.2	1,175,784.2	235,156.8	894,931.8	178,986.4	867,921.6	173,584.3
$90	1,348,123.7	134,812.4	1,276,093.5	255,218.7	980,394.7	196,078.9	988,315.3	197,663.1
$100	1,363,340.8	136,334.1	1,288,409.3	257,681.9	1,057,134.0	211,426.8	1,075,610.1	215,122.0
$110	1,365,122.4	136,512.2	1,292,427.2	258,485.4	1,102,571.4	220,514.3	1,114,460.1	222,892.0
$120	-	-	1,292,494.8	258,499.0	1,112,265.5	222,453.1	1,127,520.2	225,504.0
$130	-	-	-	-	-	-	1,132,218.7	226,443.7

Table 10. Cost availability of biomass in the Kamloops TSA, by 5-year period: low-cost grinding scenario

Base Case	Period 1 - years 1-5		Period 2 - years 6-10		Period 3 - years 11-15		Period 4 - years 16-20	
Cost $/odt	Odt Available	Odt/year	Odt Available	Odt/year	Odt Available	Odt/year	Odt Available	Odt/year
$10	-	-	-	-	-		-	-
$20	-	-	-	-	-		-	-
$30	193.1	1.9	119.2	23.8	693.9		-	-
$40	73,735.5	7,373.6	81,667.4	16,333.5	97,844.7	19,568.9	56,320.2	11,264.0
$50	530,114.9	53,011.5	454,909.4	90,981.9	334,651.3	66,930.3	265,063.3	53,012.7
$60	946,354.6	94,635.5	818,755.7	163,751.1	611,127.5	122,225.5	561,787.9	112,357.6
$70	1,171,346.5	117,134.7	1,028,648.1	205,729.6	826,384.5	165,276.9	784,229.6	156,845.9
$80	1,335,270.4	133,527.0	1,256,637.7	251,327.5	945,369.4	189,073.9	932,201.7	186,440.3
$90	1,355,212.0	135,521.2	1,283,618.4	256,723.7	1,023,769.8	204,754.0	1,028,552.6	205,710.5
$100	1,364,049.6	136,405.0	1,291,005.4	258,201.1	1,088,829.2	217,765.8	1,096,108.7	219,221.7
$110	1,365,122.4	136,512.2	1,292,494.8	258,499.0	112,265.5	22,453.1	1,121,019.8	224,204.0
$120	-	-	-	-	-	-	1,132,218.7	226,443.7
$130	-	-	-	-	-	-	-	-

6. Conclusions

We used FPInterface to develop a method for projecting available forest-origin biomass for British Columbia Timber Supply Areas in the Central Interior. The Quesnel TSA was the test case (Friesen & Goodison, 2011). Extrapolating on that experience and subsequent runs for the Williams Lake TSA (Friesen, 2012a), the model was also run for the Prince George TSA (Friesen, 2012b), the Lakes TSA (Friesen, 2012c), the Mackenzie TSA (Friesen, 2013), and the 100 Mile House TSA (Friesen, 2014). The biomass inventory was based on 20-year harvest and road network plans for Crown land (excluding TFL licenses) provided by the British Columbia Ministry of Forests, Lands and Natural Resources. The delivery point for biomass was designated as the Domtar mill in Kamloops. All planned blocks were assumed to be clearcut harvested, processed at roadside, and accessible to comminution operations.

The analysis of 20-year biomass supply in the Kamloops TSA predicts a yield of 21.8 ODT/ha from harvest residues. Over the 20-year harvest horizon a total of 4.90 million ODT of available biomass are predicted to be generated by harvest in the Kamloops TSA, or approximately 245 000 ODT/year. Of this, a total of approximately 2.35 million ODT, or 118 000 ODT/year, are expected to be available at the economic price of $60/ODT. Nearly all of the available amount is expected to be available at $90/ODT, i.e., a total of 4.59 million ODT, or 230 000 ODT/year. The biomass ratio, which is the ratio of recovered biomass to recovered merchantable roundwood, is estimated at 21.1%.

A low-cost grinding scenario was attempted, with grinding costs reduced by $4.76/ODT. At the economic rate of $60/ODT, the lower grinding cost increased availability by approximately 600 000 ODT over the 20 years, or by about 30 000 ODT/year. I.e., if efficiencies or lowered costs can be realized, available biomass could increase.

Of the biomass that is considered economically available (≤$60/ODT) most of it is located near the sity of Kamloops. The amount of economically available biomass decreases over the 20-year harvest horizon. While fewer blocks are planned in the later years of the horizon, the scale of decrease indicates that as time passes, more blocks are located further from Kamloops.

7. References

Friesen, C. (2012a). *Using FPInterface to estimate available forest-origin biomass in British Columbia: Williams Lake TSA* (Technical Report). Vancouver, British Columbia: FPInnovations.

Friesen, C. (2012b). *Using FPInterface to estimate available forest-origin biomass in British Columbia: Prince George TSA* (Technical Report). Vancouver, British Columbia: FPInnovations.

Friesen, C. (2012c). *Using FPInterface to estimate available forest-origin biomass in British Columbia: Lakes TSA* (Technical Report). Vancouver, British Columbia: FPInnovations.

Friesen, C. (2013). *Using FPInterface to estimate available forest-origin biomass in British Columbia: Mackenzie TSA* (Technical Report). Vancouver, British Columbia: FPInnovations.

Friesen, C. (2014). *Using FPInterface to estimate available forest-origin biomass in British Columbia: 100 Mile House TSA* (Technical Report). Vancouver, British Columbia: FPInnovations.

Friesen, C., & Goodison, A. (2011). *Using FPInterface to estimate available forest-origin biomass in British Columbia: Quesnel TSA* (Technical Report). Vancouver, British Columbia: FPInnovations.

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Mellgren, P.G. (1980) *Terrain classification for Canadian forestry*. Woodlands Section, Canadian Pulp and Paper Association (CPPA).

Ung, C-H., Bernier, P. & Guo, X-J. (2008). Canadian national biomass equations: New parameter estimates that include British Columbia data. *Canadian Journal of Forest Research* 38:1123–1132.

8. Appendix

Biomass - Kamloops - pd 1.pdf
Biomass - Kamloops - pd 2.pdf
Biomass - Kamloops - pd 3.pdf
Biomass - Kamloops - pd 4.pdf
Biomass - Kamloops scen 1 - pd 1.pdf
Biomass - Kamloops scen 1 - pd 2.pdf
Biomass - Kamloops scen 1 - pd 3.pdf
Biomass - Kamloops scen 1 - pd 4.pdf
Biomass - Kamloops scen 1.pdf
Biomass - Kamloops.pdf

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	63,418.6 ha
Number of cut blocks	624
Recovered biomass	1,365,122.4 odt
Biomass yield	21.5 odt/ha
Biomass odt / Merchantable m^3	0.0978 odt/m^3
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	30 : 1
Available energy	5,403,539 MWh
Fuel consumption	15.1 L/odt

Cost

Harvesting	0.00 $/odt
Biomass recovery	25.89 $/odt
Transfer yard	0.00 $/odt
Transportation	33.16 $/odt
Loading/unloading	0.00 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	0.88 $/odt
Indirect costs	0.00 $/odt
Total	59.93 $/odt

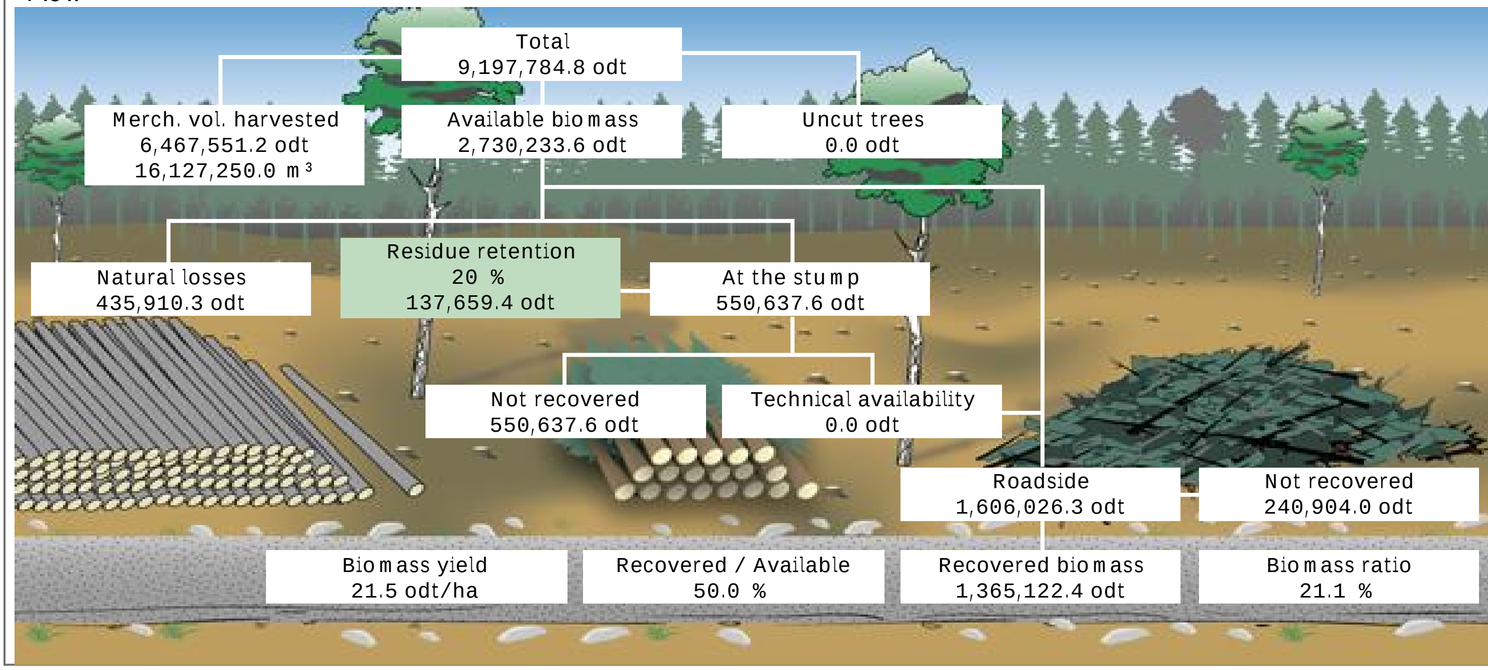
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

Profit	-59.93 $/odt

Flow



Products

Product name	odt	odt/m³	odt/ha
Douglas-fir (residues)	490,116.1	0.1365	7.73
Pine (residues)	419,026.2	0.0861	6.61
Spruce (residues)	316,086.9	0.0913	4.98
Abies (residues)	85,567.0	0.0682	1.35
Cedar (residues)	28,407.1	0.0676	0.45
Hemlock (residues)	22,545.0	0.0641	0.36
Oak (residues)	3,374.1	0.2384	0.05
	1,365,122.4	0.0978	21.53

Recovery summary

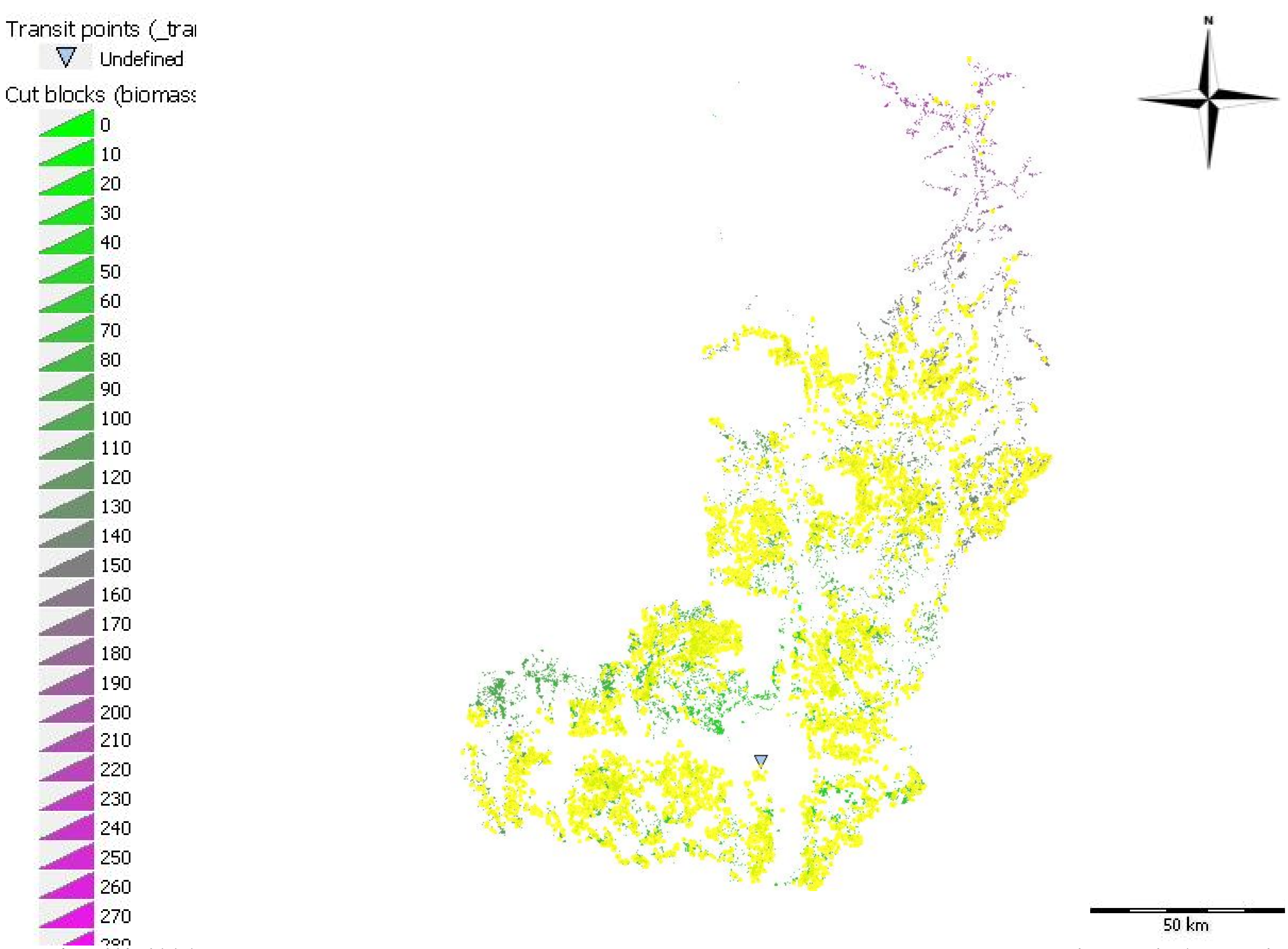
	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	1,365,122.4	63,418.6	624
• Recovery season			
Summer	0.0	0.0	0
Winter	1,365,122.4	63,418.6	624
• Residue freshness			
Fresh	0.0	0.0	0
Brown	1,365,122.4	63,418.6	624
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	0.0	0.0
40 $/odt	0.0	7,318.5	7,318.5
50 $/odt	0.0	255,720.4	255,720.4
60 $/odt	0.0	781,442.8	781,442.8
70 $/odt	0.0	1,059,179.4	1,059,179.4
80 $/odt	0.0	1,311,161.6	1,311,161.6
90 $/odt	0.0	1,348,123.7	1,348,123.7
100 $/odt	0.0	1,363,340.8	1,363,340.8
110 $/odt	0.0	1,365,122.4	1,365,122.4
Maximum cost	0.00 $/odt	109.79 $/odt	

Delivery to mills

Destination	Product	Format	odt	Transport average distance (Km)
Domtar Mill				
	Abies (residues)	Chips	85,567	126
	Cedar (residues)	Chips	28,407	150
	Douglas-fir (residues)	Chips	490,116	82
	Hemlock (residues)	Chips	22,545	166
	Oak (residues)	Chips	3,374	123
	Pine (residues)	Chips	419,026	96
	Spruce (residues)	Chips	316,087	111
			1,365,122	99
			1,365,122	99



624 selected block(s) / 2735

Area covered: 63,419 ha / 224,473 ha

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	57,476.7 ha
Number of cut blocks	688
Recovered biomass	1,292,494.8 odt
Biomass yield	22.5 odt/ha
Biomass odt / Merchantable m^3	0.0944 odt/m^3
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	29 : 1
Available energy	5,127,329 MWh
Fuel consumption	15.8 L/odt

Cost

Harvesting	0.00 $/odt
Biomass recovery	25.89 $/odt
Transfer yard	0.00 $/odt
Transportation	34.90 $/odt
Loading/unloading	0.00 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	0.92 $/odt
Indirect costs	0.00 $/odt
Total	61.72 $/odt

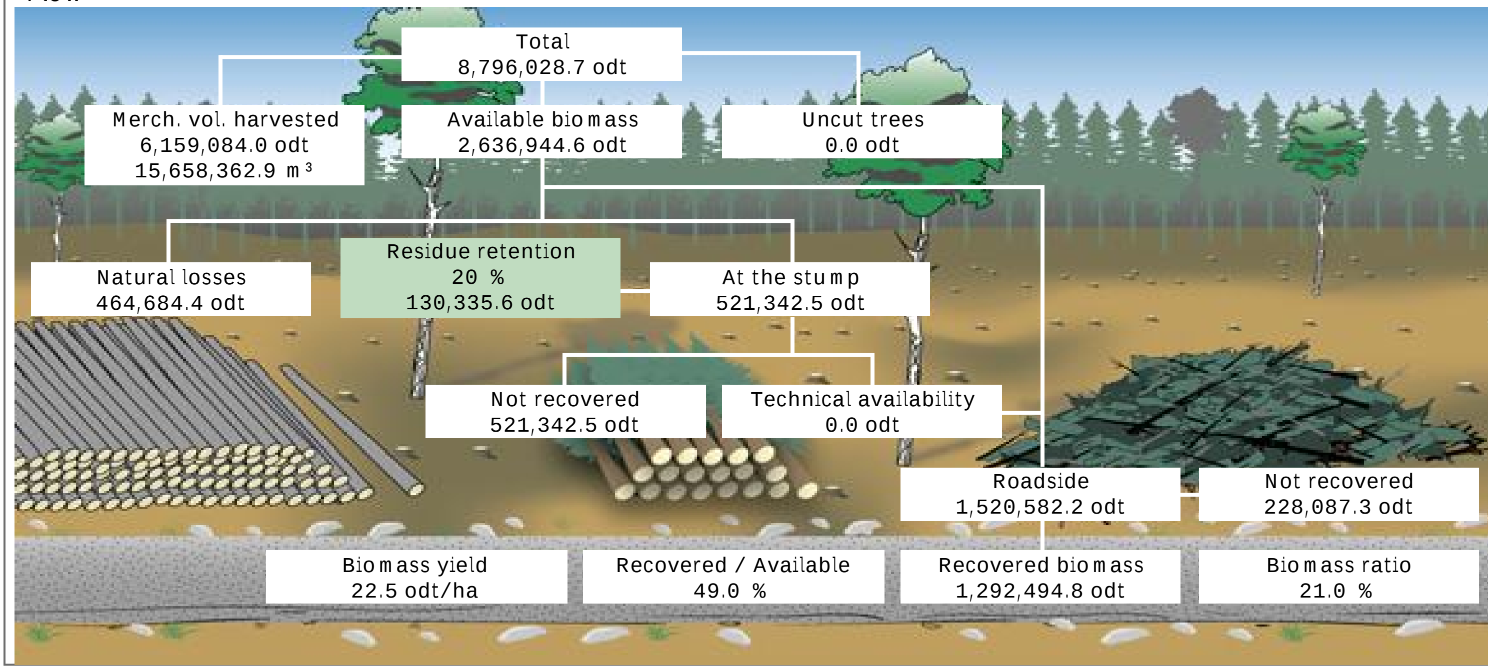
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

Profit	-61.72 $/odt

Flow



Products

Product name	odt	odt/m³	odt/ha
Douglas-fir (residues)	585,687.9	0.1276	10.19
Spruce (residues)	351,379.1	0.0872	6.11
Abies (residues)	140,246.8	0.0702	2.44
Pine (residues)	111,144.4	0.0736	1.93
Cedar (residues)	48,014.1	0.0638	0.84
Hemlock (residues)	47,521.1	0.0615	0.83
Oak (residues)	8,494.7	0.2191	0.15
Larch (residues)	6.7	0.1199	0.00
	1,292,494.8	0.0944	22.49

Recovery summary

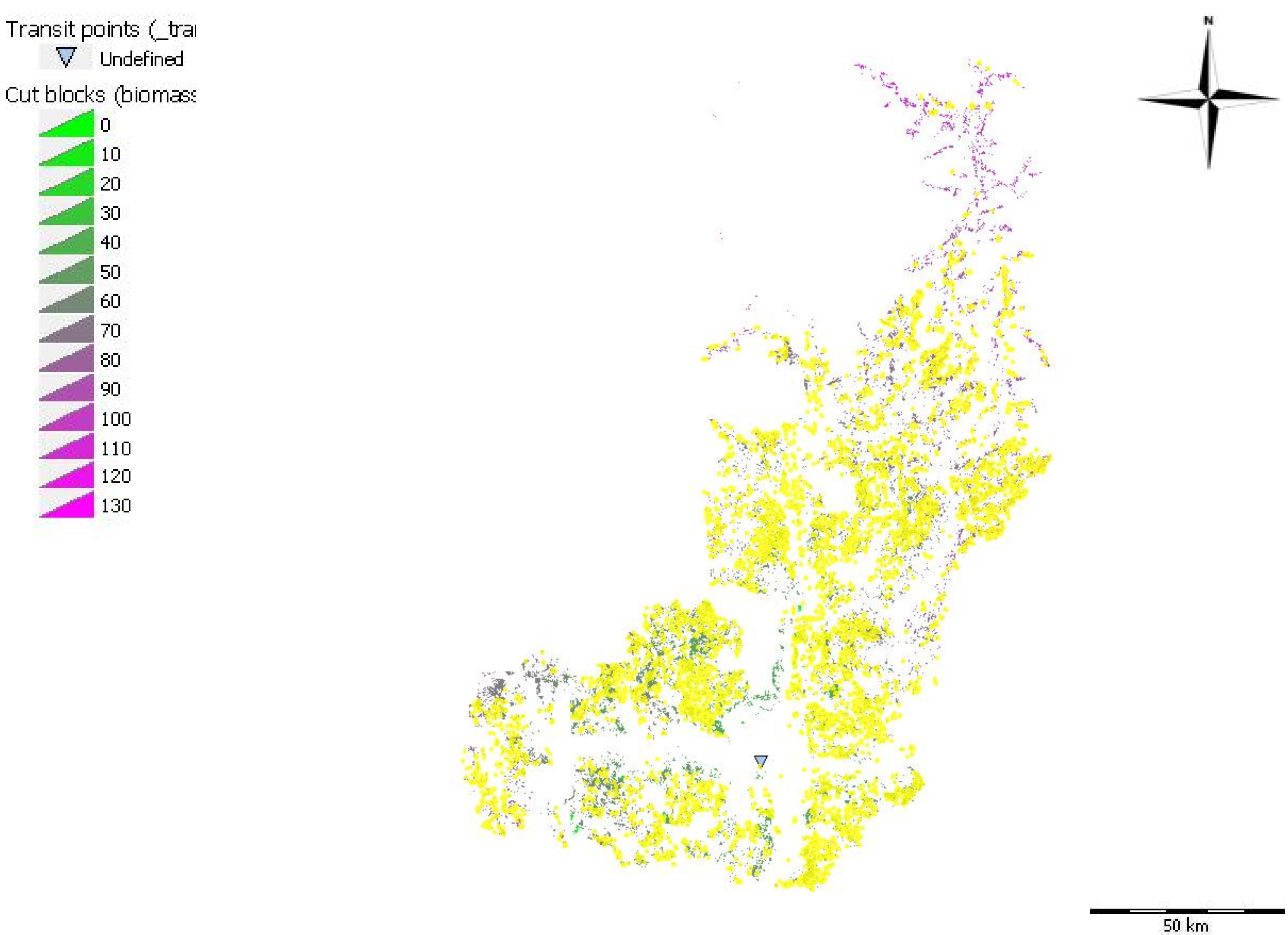
	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	1,292,494.8	57,518.8	689
• Recovery season			
Summer	0.0	0.0	0
Winter	1,292,494.8	57,518.8	689
• Residue freshness			
Fresh	0.0	0.0	0
Brown	1,292,494.8	57,518.8	689
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	0.0	0.0
40 $/odt	0.0	9,885.3	9,885.3
50 $/odt	0.0	249,843.8	249,843.8
60 $/odt	0.0	646,570.9	646,570.9
70 $/odt	0.0	911,939.4	911,939.4
80 $/odt	0.0	1,175,784.2	1,175,784.2
90 $/odt	0.0	1,276,093.5	1,276,093.5
100 $/odt	0.0	1,288,409.3	1,288,409.3
110 $/odt	0.0	1,292,427.2	1,292,427.2
120 $/odt	0.0	1,292,494.8	1,292,494.8
Maximum cost	0.00 $/odt	111.86 $/odt	

Delivery to mills

Destination	Product	Format	odt	Transport average distance (Km)
Domtar Mill				
	Abies (residues)	Chips	140,247	144
	Cedar (residues)	Chips	48,014	165
	Douglas-fir (residues)	Chips	585,688	82
	Hemlock (residues)	Chips	47,521	183
	Larch (residues)	Chips	7	112
	Oak (residues)	Chips	8,495	126
	Pine (residues)	Chips	111,144	95
	Spruce (residues)	Chips	351,379	124
			1,292,495	108
			1,292,495	108



689 selected block(s) / 2735

Area covered: 57,477 ha / 224,431 ha

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	51,378.5 ha
Number of cut blocks	728
Recovered biomass	1,112,265.5 odt
Biomass yield	21.6 odt/ha
Biomass odt / Merchantable m^3	0.0899 odt/m^3
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	27 : 1
Available energy	4,428,205 MWh
Fuel consumption	17.2 L/odt

Cost

Harvesting	0.00 $/odt
Biomass recovery	25.89 $/odt
Transfer yard	0.00 $/odt
Transportation	38.54 $/odt
Loading/unloading	0.00 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	1.31 $/odt
Indirect costs	0.00 $/odt
Total	65.74 $/odt

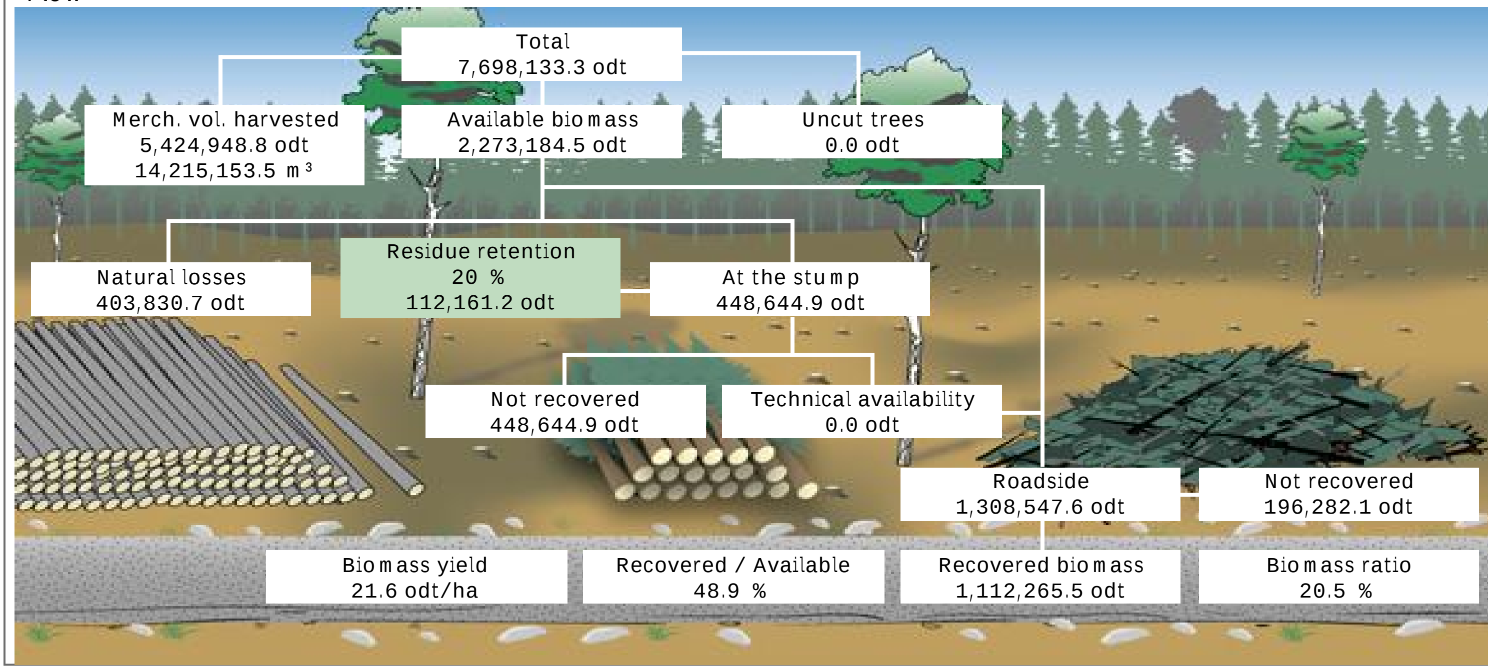
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

Profit	-65.74 $/odt

Flow



Products

Product name	odt	odt/m³	odt/ha
Douglas-fir (residues)	454,528.6	0.1360	8.85
Spruce (residues)	330,742.5	0.0857	6.44
Abies (residues)	102,502.3	0.0690	2.00
Cedar (residues)	80,458.9	0.0535	1.57
Hemlock (residues)	77,370.5	0.0514	1.51
Pine (residues)	62,408.4	0.0944	1.21
Oak (residues)	4,252.8	0.2283	0.08
Larch (residues)	1.5	0.1800	0.00
	1,112,265.5	0.0899	21.65

Recovery summary

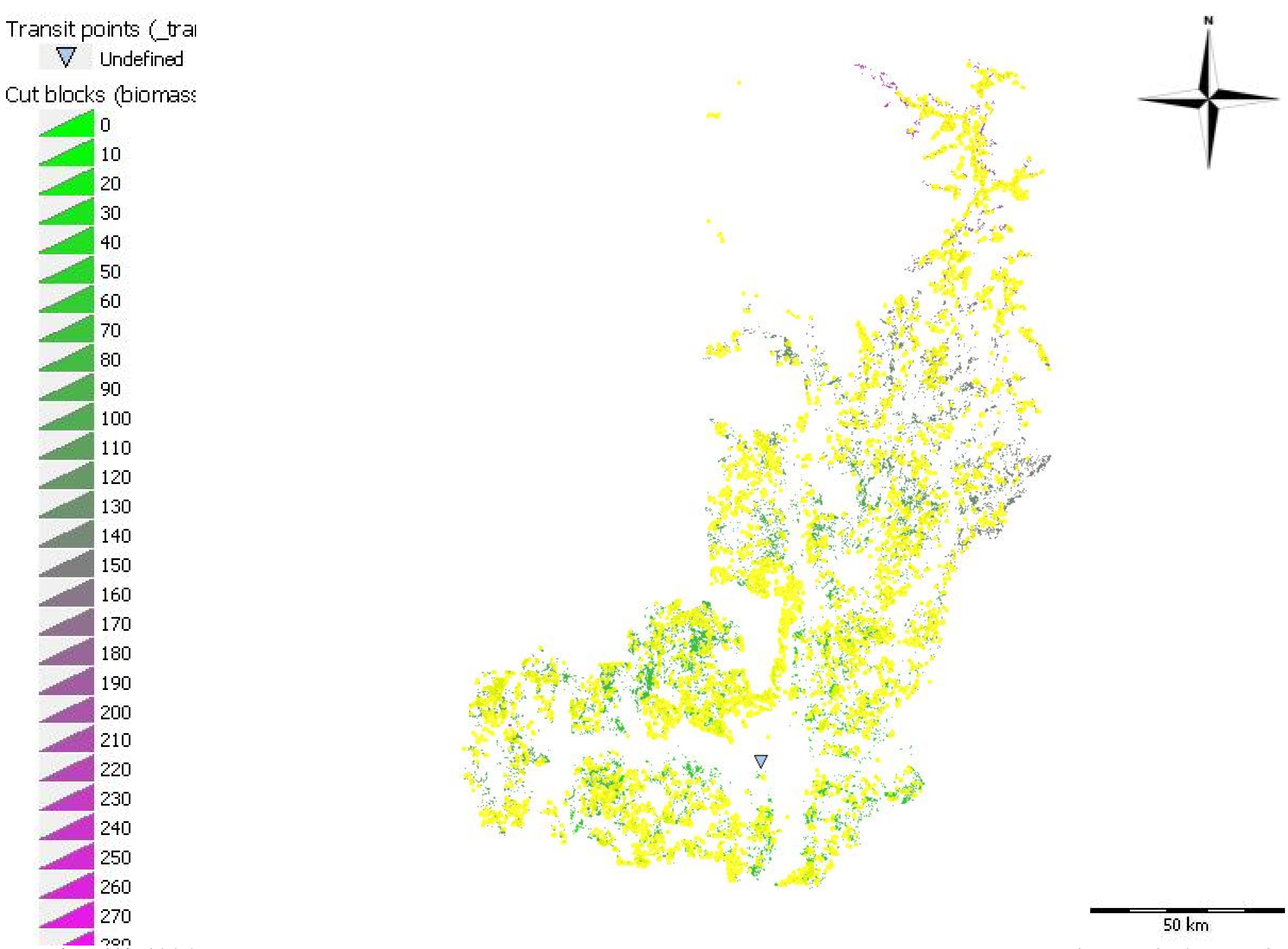
	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	1,112,265.5	51,378.5	728
• Recovery season			
Summer	0.0	0.0	0
Winter	1,112,265.5	51,378.5	728
• Residue freshness			
Fresh	0.0	0.0	0
Brown	1,112,265.5	51,378.5	728
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	598.1	598.1
40 $/odt	0.0	6,612.4	6,612.4
50 $/odt	0.0	182,986.9	182,986.9
60 $/odt	0.0	476,603.1	476,603.1
70 $/odt	0.0	724,331.6	724,331.6
80 $/odt	0.0	894,931.8	894,931.8
90 $/odt	0.0	980,394.7	980,394.7
100 $/odt	0.0	1,057,134.0	1,057,134.0
110 $/odt	0.0	1,102,571.4	1,102,571.4
120 $/odt	0.0	1,112,265.5	1,112,265.5
Maximum cost	0.00 $/odt	114.06 $/odt	

Delivery to mills

Destination	Product	Format	odt	Transport average distance (Km)
Domtar Mill				
	Abies (residues)	Chips	102,502	145
	Cedar (residues)	Chips	80,459	209
	Douglas-fir (residues)	Chips	454,529	84
	Hemlock (residues)	Chips	77,371	222
	Larch (residues)	Chips	2	45
	Oak (residues)	Chips	4,253	144
	Pine (residues)	Chips	62,408	78
	Spruce (residues)	Chips	330,742	132
			1,112,265	122
			1,112,265	122



728 selected block(s) / 2735

Area covered: 51,378 ha / 224,473 ha

FPInterface™

Summary report
Biomass
[Kamloops]

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	52,156.8 ha
Number of cut blocks	694
Recovered biomass	1,132,218.7 odt
Biomass yield	21.7 odt/ha
Biomass odt / Merchantable m^3	0.0959 odt/m^3
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	25 : 1
Available energy	4,503,359 MWh
Fuel consumption	18.0 L/odt

Cost

Harvesting	0.00 $/odt
Biomass recovery	25.89 $/odt
Transfer yard	0.00 $/odt
Transportation	40.82 $/odt
Loading/unloading	0.00 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	1.39 $/odt
Indirect costs	0.00 $/odt
Total	68.11 $/odt

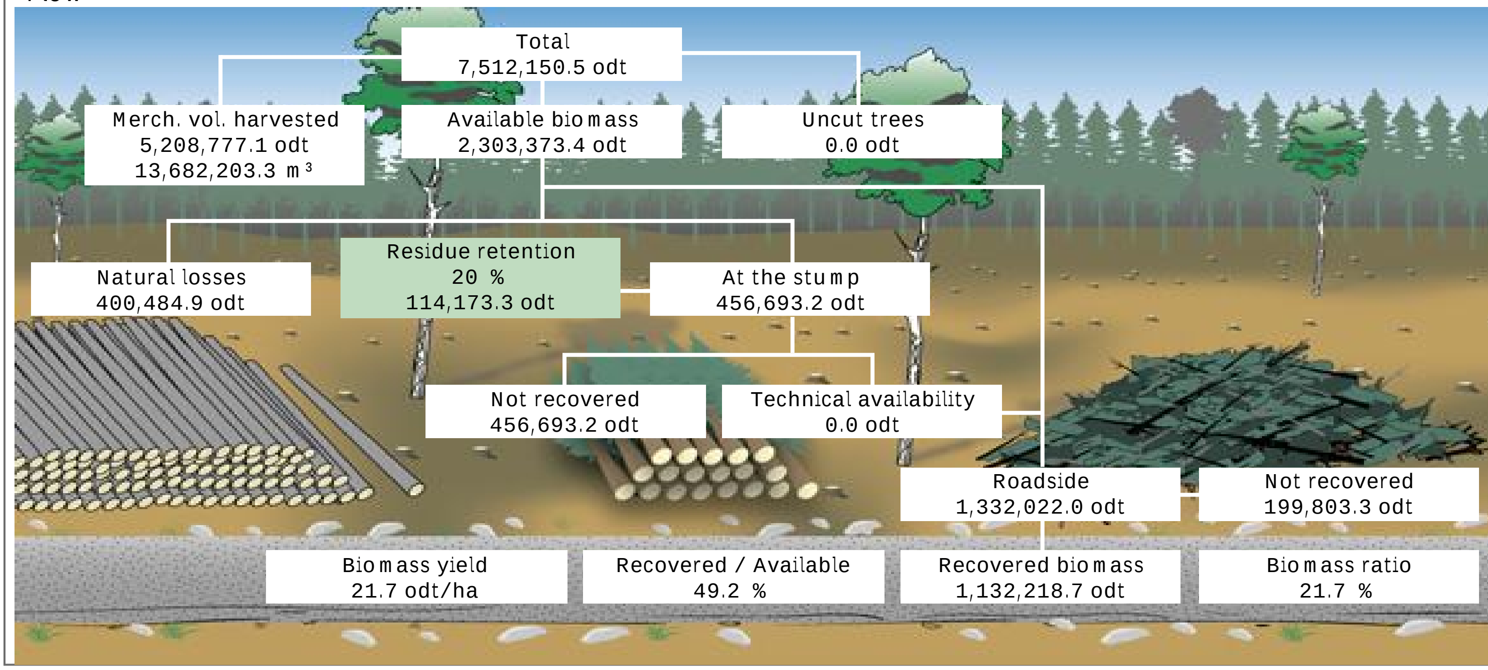
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

Profit	-68.11 $/odt

Flow



Products

Product name	odt	odt/m³	odt/ha
Douglas-fir (residues)	443,158.8	0.1505	8.50
Spruce (residues)	314,302.8	0.0859	6.03
Abies (residues)	114,445.0	0.0652	2.19
Pine (residues)	102,772.8	0.1272	1.97
Hemlock (residues)	77,097.5	0.0573	1.48
Cedar (residues)	73,883.1	0.0585	1.42
Oak (residues)	6,413.3	0.2311	0.12
Larch (residues)	145.4	0.0826	0.00
	1,132,218.7	0.0959	21.71

Recovery summary

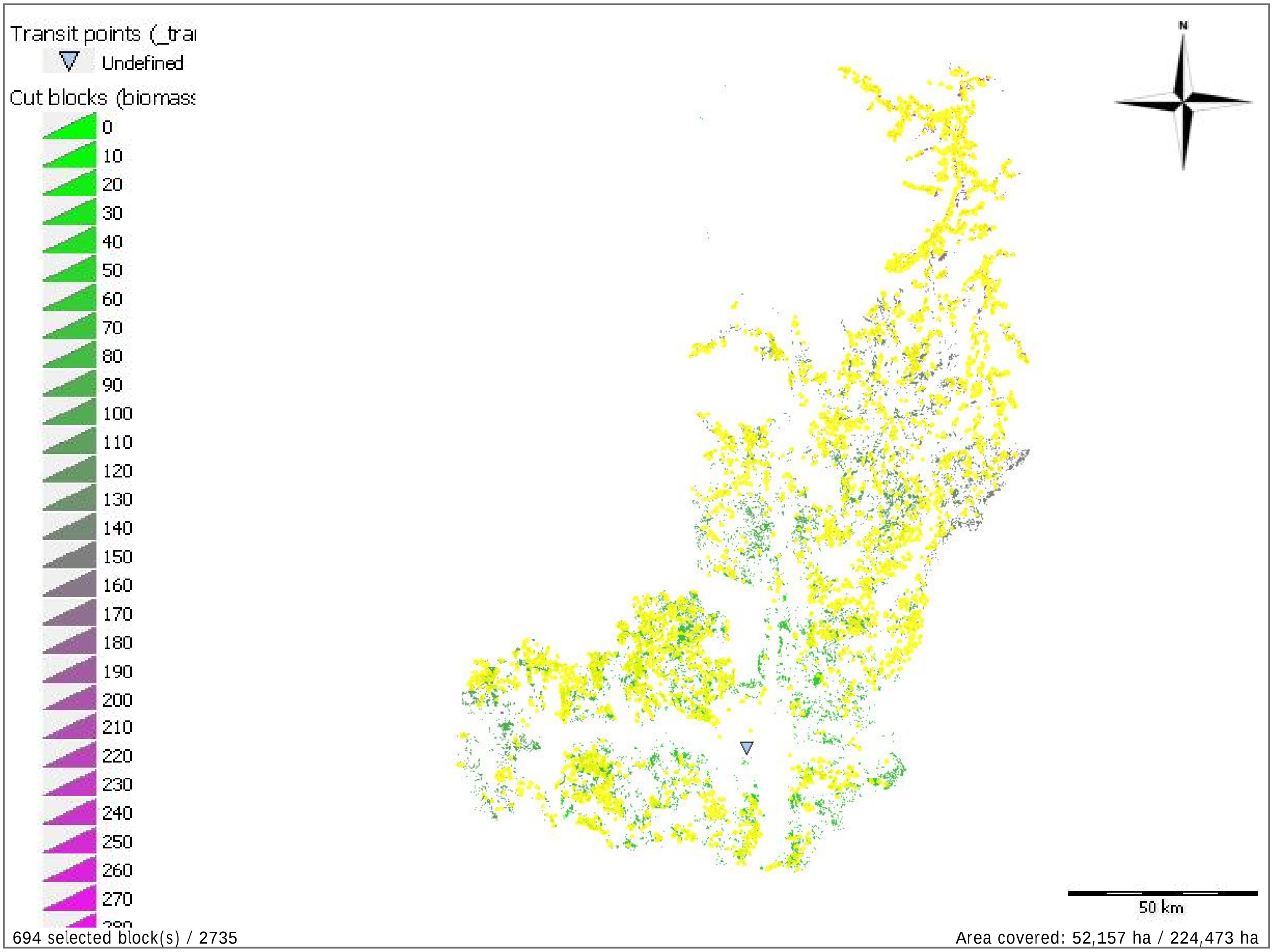
	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	1,132,218.7	52,156.8	694
• Recovery season			
Summer	0.0	0.0	0
Winter	1,132,218.7	52,156.8	694
• Residue freshness			
Fresh	0.0	0.0	0
Brown	1,132,218.7	52,156.8	694
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	0.0	0.0
40 $/odt	0.0	3,558.6	3,558.6
50 $/odt	0.0	147,826.3	147,826.3
60 $/odt	0.0	447,576.2	447,576.2
70 $/odt	0.0	685,418.2	685,418.2
80 $/odt	0.0	867,921.6	867,921.6
90 $/odt	0.0	988,315.3	988,315.3
100 $/odt	0.0	1,075,610.1	1,075,610.1
110 $/odt	0.0	1,114,460.1	1,114,460.1
120 $/odt	0.0	1,127,520.2	1,127,520.2
130 $/odt	0.0	1,132,218.7	1,132,218.7
Maximum cost	0.00 $/odt	123.76 $/odt	

Delivery to mills

Destination	Product	Format	odt	Transport average distance (Km)
Domtar Mill				
	Abies (residues)	Chips	114,445	170
	Cedar (residues)	Chips	73,883	206
	Douglas-fir (residues)	Chips	443,159	91
	Hemlock (residues)	Chips	77,098	221
	Larch (residues)	Chips	145	172
	Oak (residues)	Chips	6,413	160
	Pine (residues)	Chips	102,773	86
	Spruce (residues)	Chips	314,303	153
			1,132,219	133
			1,132,219	133


Transit points (_trai
Undefined
Cut blocks (biomass
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
N
50 km
694 selected block(s) / 2735
Area covered: 52,157 ha / 224,473 ha

FPInterface™

Summary report

Biomass

[Kamloops scen 1]

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	63,418.6 ha
Number of cut blocks	624
Recovered biomass	1,365,122.4 odt
Biomass yield	21.5 odt/ha
Biomass odt / Merchantable m^3	0.0978 odt/m^3
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	33 : 1
Available energy	5,403,539 MWh
Fuel consumption	13.7 L/odt

Cost

Harvesting	0.00 $/odt
Biomass recovery	21.23 $/odt
Transfer yard	0.00 $/odt
Transportation	33.16 $/odt
Loading/unloading	0.00 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	0.88 $/odt
Indirect costs	0.00 $/odt
Total	55.27 $/odt

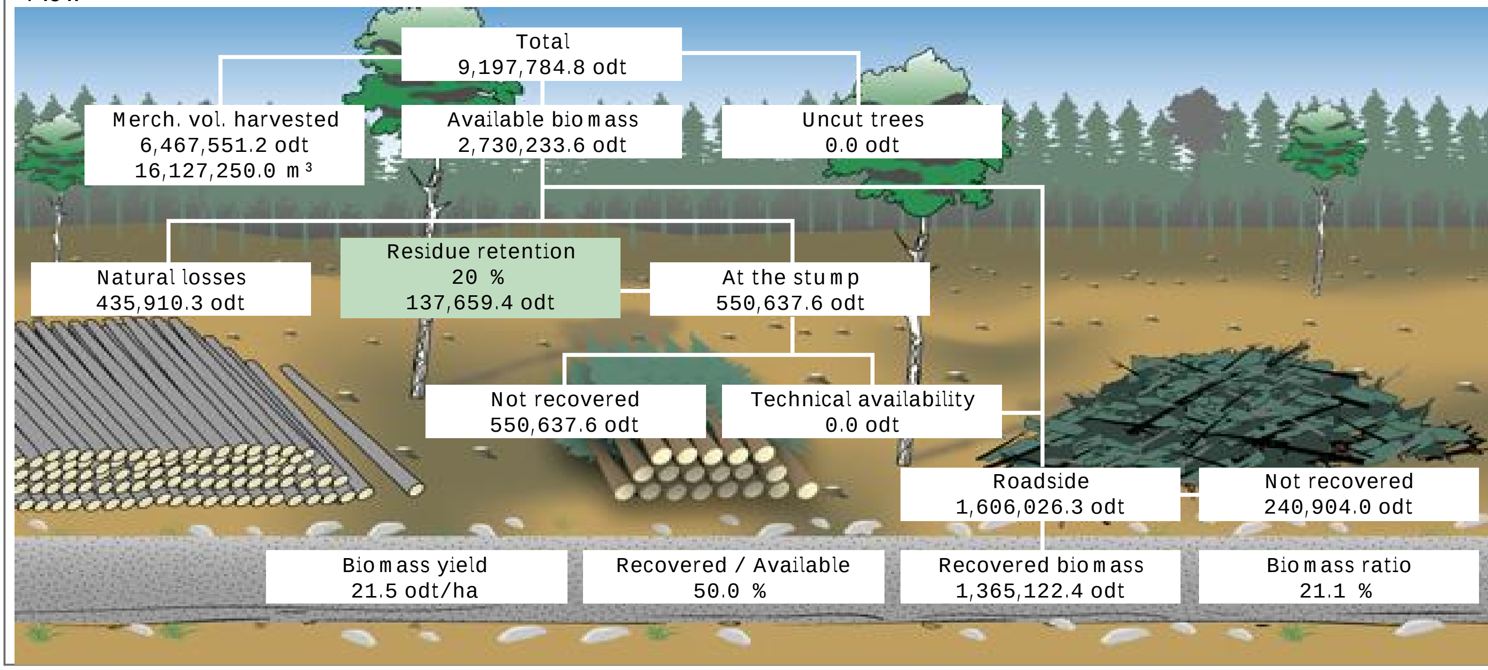
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

Profit	-55.27 $/odt

Flow



Products

Product name	odt	odt/m³	odt/ha
Douglas-fir (residues)	490,116.1	0.1365	7.73
Pine (residues)	419,026.2	0.0861	6.61
Spruce (residues)	316,086.9	0.0913	4.98
Abies (residues)	85,567.0	0.0682	1.35
Cedar (residues)	28,407.1	0.0676	0.45
Hemlock (residues)	22,545.0	0.0641	0.36
Oak (residues)	3,374.1	0.2384	0.05
	1,365,122.4	0.0978	21.53

Recovery summary

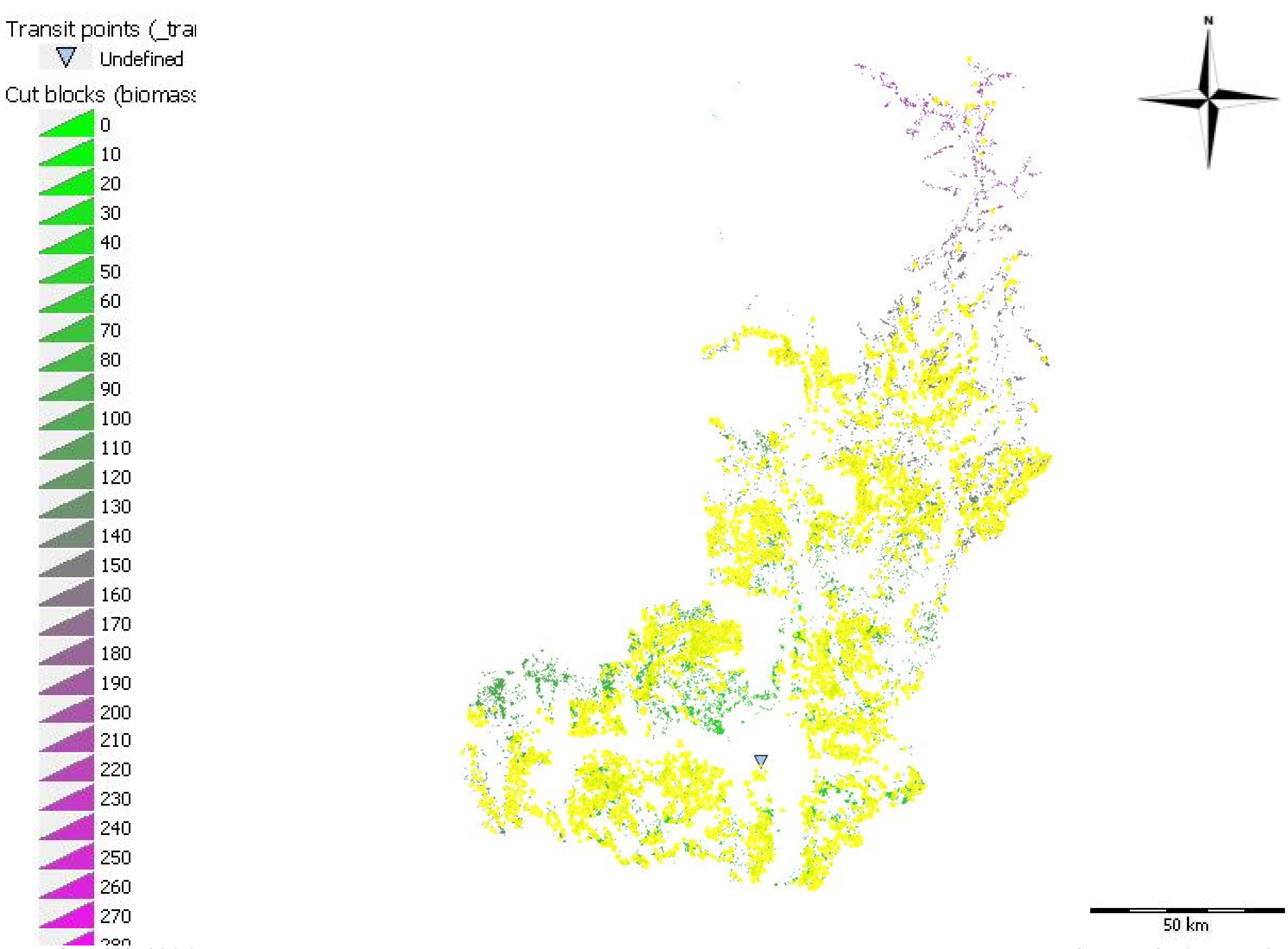
	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	1,365,122.4	63,418.6	624
• Recovery season			
Summer	0.0	0.0	0
Winter	1,365,122.4	63,418.6	624
• Residue freshness			
Fresh	0.0	0.0	0
Brown	1,365,122.4	63,418.6	624
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	193.1	193.1
40 $/odt	0.0	73,735.5	73,735.5
50 $/odt	0.0	530,114.9	530,114.9
60 $/odt	0.0	946,354.6	946,354.6
70 $/odt	0.0	1,171,346.5	1,171,346.5
80 $/odt	0.0	1,335,270.4	1,335,270.4
90 $/odt	0.0	1,355,212.0	1,355,212.0
100 $/odt	0.0	1,364,049.6	1,364,049.6
110 $/odt	0.0	1,365,122.4	1,365,122.4
Maximum cost	0.00 $/odt	105.12 $/odt	

Delivery to mills

Destination	Product	Format	odt	Transport average distance (Km)
Domtar Mill				
	Abies (residues)	Chips	85,567	126
	Cedar (residues)	Chips	28,407	150
	Douglas-fir (residues)	Chips	490,116	82
	Hemlock (residues)	Chips	22,545	166
	Oak (residues)	Chips	3,374	123
	Pine (residues)	Chips	419,026	96
	Spruce (residues)	Chips	316,087	111
			1,365,122	99
			1,365,122	99



624 selected block(s) / 2735

Area covered: 63,419 ha / 224,473 ha

FPInterface™

Summary report
Biomass
[Kamloops scen 1]

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	57,476.7 ha
Number of cut blocks	688
Recovered biomass	1,292,494.8 odt
Biomass yield	22.5 odt/ha
Biomass odt / Merchantable m^3	0.0944 odt/m^3
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	32 : 1
Available energy	5,127,329 MWh
Fuel consumption	14.4 L/odt

Cost

Harvesting	0.00 $/odt
Biomass recovery	21.23 $/odt
Transfer yard	0.00 $/odt
Transportation	34.90 $/odt
Loading/unloading	0.00 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	0.92 $/odt
Indirect costs	0.00 $/odt
Total	57.05 $/odt

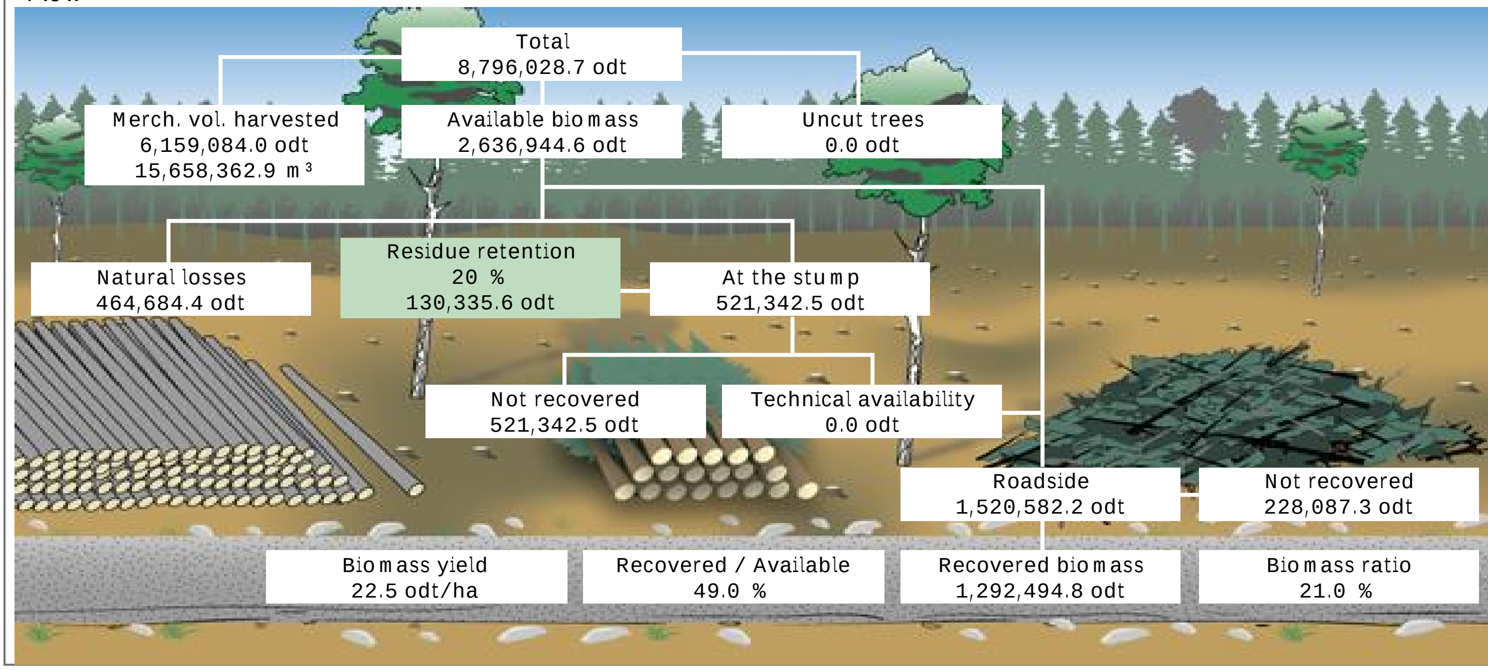
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

Profit	-57.05 $/odt

Flow



Products

Product name	odt	odt/m³	odt/ha
Douglas-fir (residues)	585,687.9	0.1276	10.19
Spruce (residues)	351,379.1	0.0872	6.11
Abies (residues)	140,246.8	0.0702	2.44
Pine (residues)	111,144.4	0.0736	1.93
Cedar (residues)	48,014.1	0.0638	0.84
Hemlock (residues)	47,521.1	0.0615	0.83
Oak (residues)	8,494.7	0.2191	0.15
Larch (residues)	6.7	0.1199	0.00
	1,292,494.8	0.0944	22.49

Recovery summary

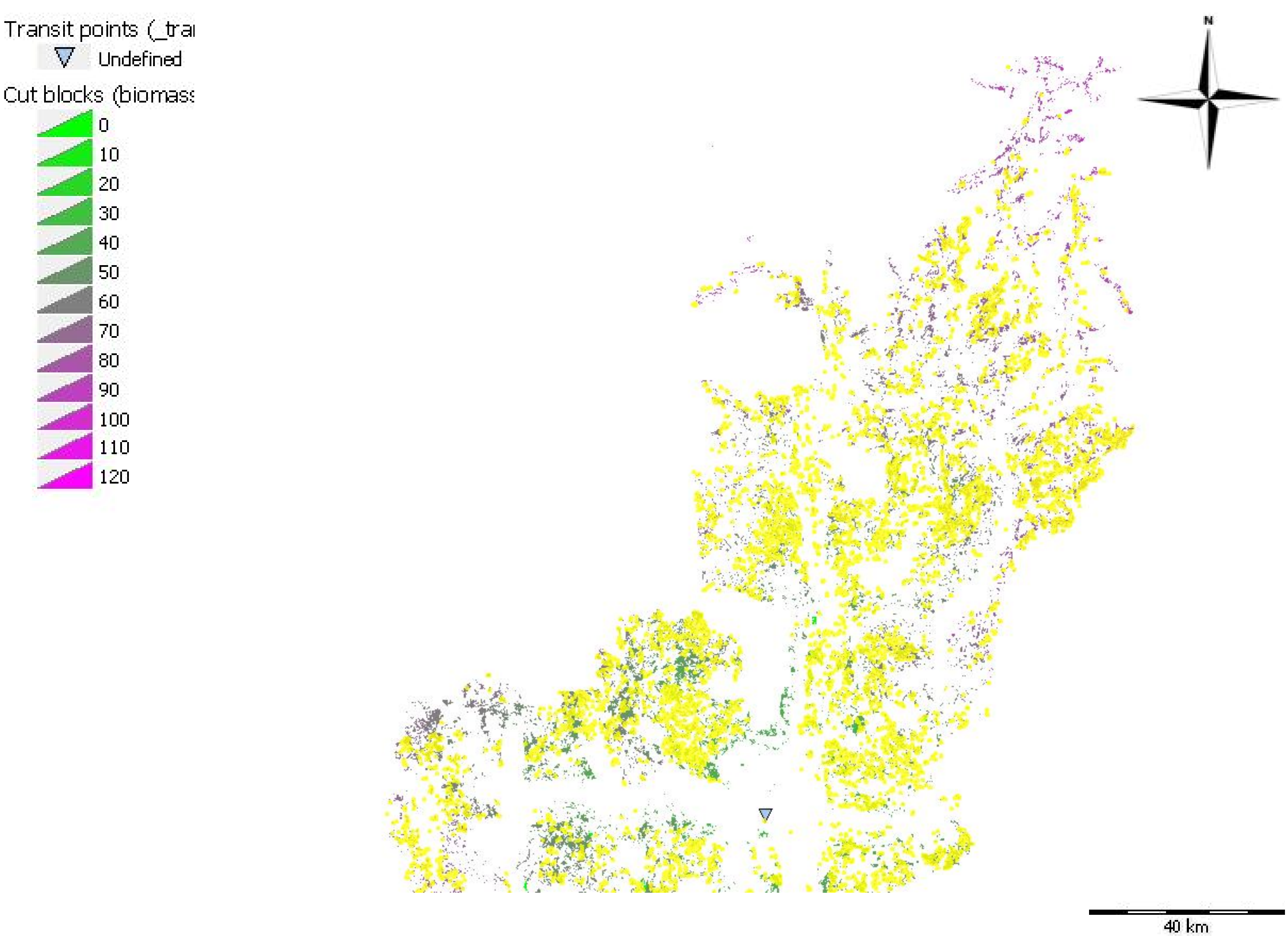
	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	1,292,494.8	57,518.8	689
• Recovery season			
Summer	0.0	0.0	0
Winter	1,292,494.8	57,518.8	689
• Residue freshness			
Fresh	0.0	0.0	0
Brown	1,292,494.8	57,518.8	689
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	119.2	119.2
40 $/odt	0.0	81,667.4	81,667.4
50 $/odt	0.0	454,909.4	454,909.4
60 $/odt	0.0	818,755.7	818,755.7
70 $/odt	0.0	1,028,648.1	1,028,648.1
80 $/odt	0.0	1,256,637.7	1,256,637.7
90 $/odt	0.0	1,283,618.4	1,283,618.4
100 $/odt	0.0	1,291,005.4	1,291,005.4
110 $/odt	0.0	1,292,494.8	1,292,494.8
Maximum cost	0.00 $/odt	107.20 $/odt	

Delivery to mills

Destination	Product	Format	odt	Transport average distance (Km)
Domtar Mill				
	Abies (residues)	Chips	140,247	144
	Cedar (residues)	Chips	48,014	165
	Douglas-fir (residues)	Chips	585,688	82
	Hemlock (residues)	Chips	47,521	183
	Larch (residues)	Chips	7	112
	Oak (residues)	Chips	8,495	126
	Pine (residues)	Chips	111,144	95
	Spruce (residues)	Chips	351,379	124
			1,292,495	108
			1,292,495	108



689 selected block(s) / 2735

Area covered: 57,477 ha / 224,431 ha

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	51,378.5 ha
Number of cut blocks	728
Recovered biomass	1,112,265.5 odt
Biomass yield	21.6 odt/ha
Biomass odt / Merchantable m^3	0.0899 odt/m^3
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	29 : 1
Available energy	4,428,205 MWh
Fuel consumption	15.7 L/odt

Cost

Harvesting	0.00 $/odt
Biomass recovery	21.23 $/odt
Transfer yard	0.00 $/odt
Transportation	38.54 $/odt
Loading/unloading	0.00 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	1.31 $/odt
Indirect costs	0.00 $/odt
Total	61.08 $/odt

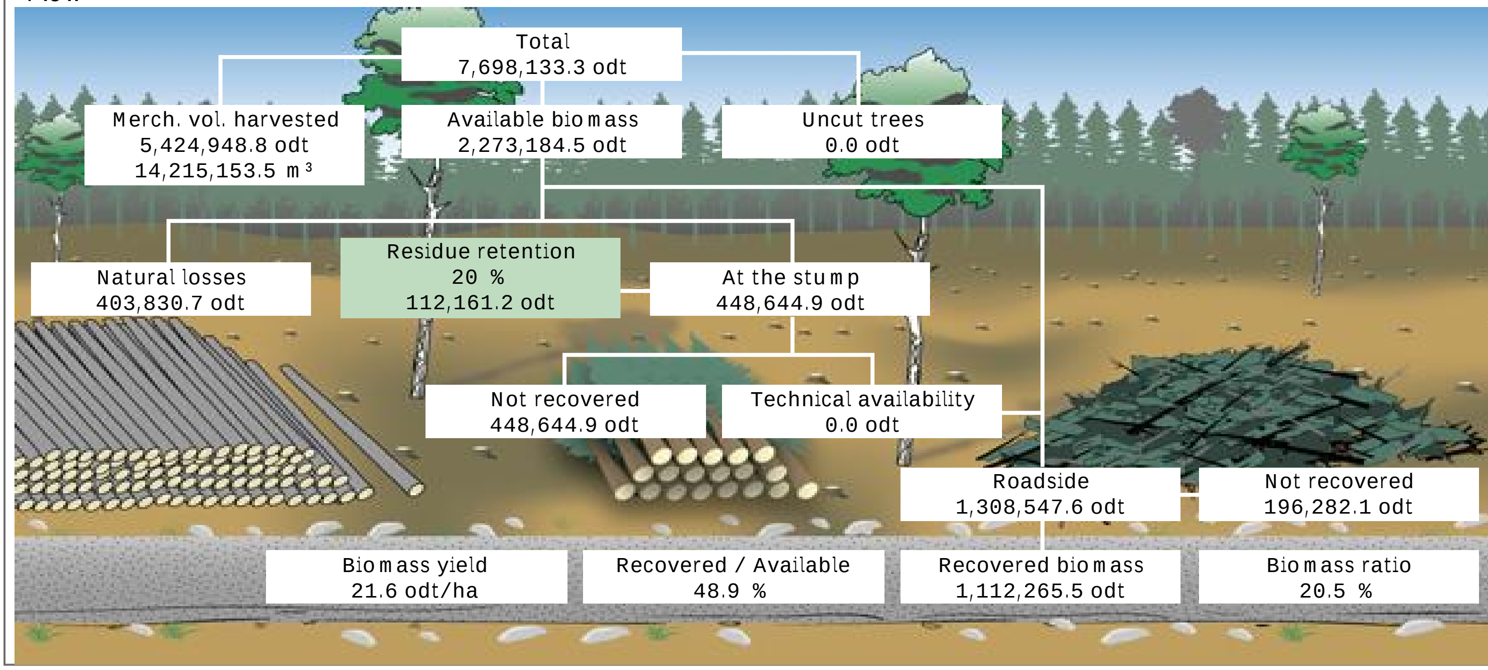
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

Profit	-61.08 $/odt

Flow



Products

Product name	odt	odt/m³	odt/ha
Douglas-fir (residues)	454,528.6	0.1360	8.85
Spruce (residues)	330,742.5	0.0857	6.44
Abies (residues)	102,502.3	0.0690	2.00
Cedar (residues)	80,458.9	0.0535	1.57
Hemlock (residues)	77,370.5	0.0514	1.51
Pine (residues)	62,408.4	0.0944	1.21
Oak (residues)	4,252.8	0.2283	0.08
Larch (residues)	1.5	0.1800	0.00
	1,112,265.5	0.0899	21.65

Recovery summary

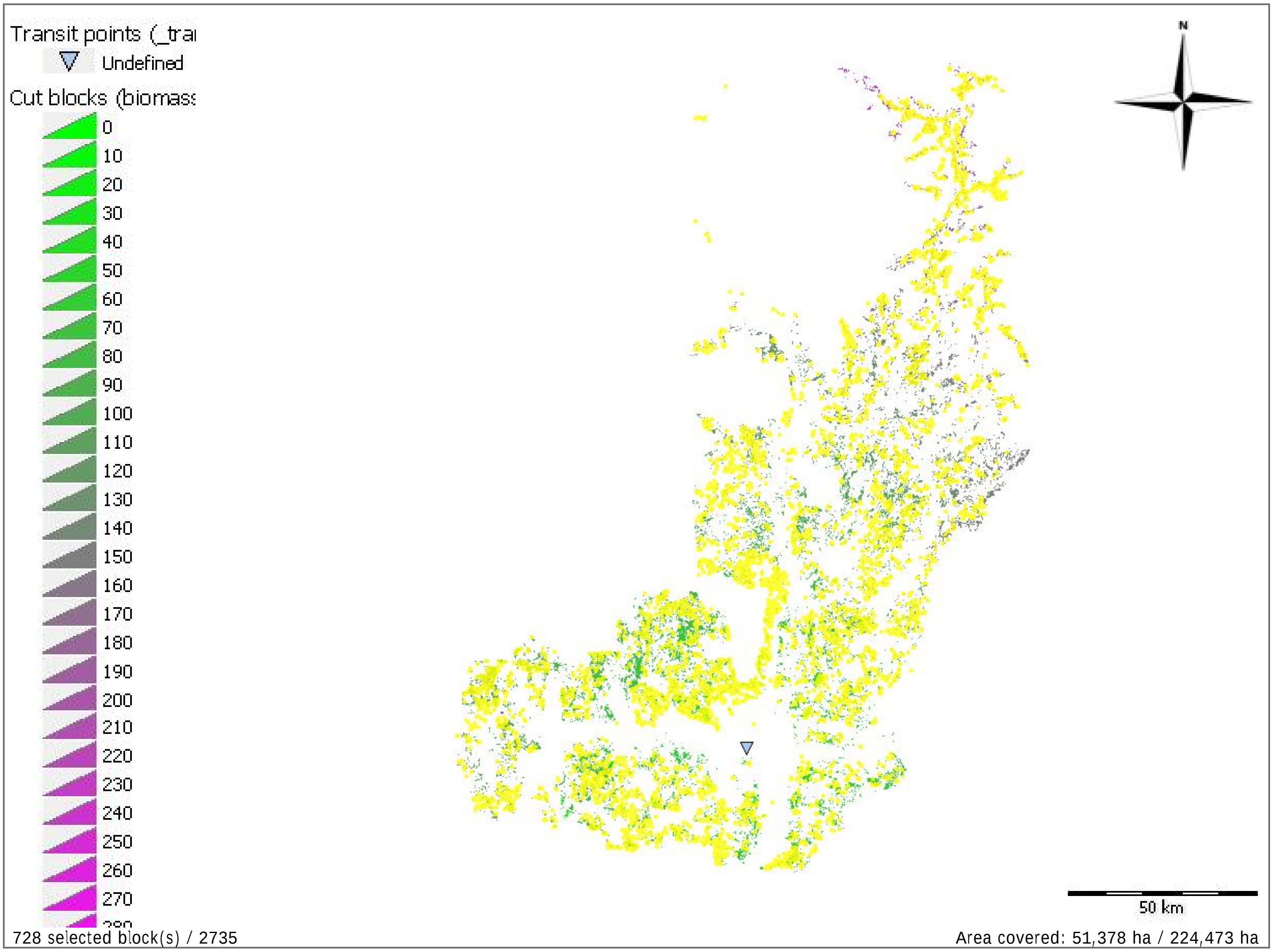
	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	1,112,265.5	51,378.5	728
• Recovery season			
Summer	0.0	0.0	0
Winter	1,112,265.5	51,378.5	728
• Residue freshness			
Fresh	0.0	0.0	0
Brown	1,112,265.5	51,378.5	728
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	693.9	693.9
40 $/odt	0.0	97,844.7	97,844.7
50 $/odt	0.0	334,651.3	334,651.3
60 $/odt	0.0	611,127.5	611,127.5
70 $/odt	0.0	826,384.5	826,384.5
80 $/odt	0.0	945,369.4	945,369.4
90 $/odt	0.0	1,023,769.8	1,023,769.8
100 $/odt	0.0	1,088,829.2	1,088,829.2
110 $/odt	0.0	1,112,265.5	1,112,265.5
Maximum cost	0.00 $/odt	109.40 $/odt	

Delivery to mills

Destination	Product	Format	odt	Transport average distance (Km)
Domtar Mill				
	Abies (residues)	Chips	102,502	145
	Cedar (residues)	Chips	80,459	209
	Douglas-fir (residues)	Chips	454,529	84
	Hemlock (residues)	Chips	77,371	222
	Larch (residues)	Chips	2	45
	Oak (residues)	Chips	4,253	144
	Pine (residues)	Chips	62,408	78
	Spruce (residues)	Chips	330,742	132
			1,112,265	122
			1,112,265	122


Transit points (_trai
Undefined
Cut blocks (biomass
0
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140
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180
190
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240
250
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270
N
50 km
728 selected block(s) / 2735
Area covered: 51,378 ha / 224,473 ha

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	52,156.8 ha
Number of cut blocks	694
Recovered biomass	1,132,218.7 odt
Biomass yield	21.7 odt/ha
Biomass odt / Merchantable m^3	0.0959 odt/m^3
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	28 : 1
Available energy	4,503,359 MWh
Fuel consumption	16.5 L/odt

Cost

Harvesting	0.00 $/odt
Biomass recovery	21.23 $/odt
Transfer yard	0.00 $/odt
Transportation	40.82 $/odt
Loading/unloading	0.00 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	1.39 $/odt
Indirect costs	0.00 $/odt
Total	63.44 $/odt

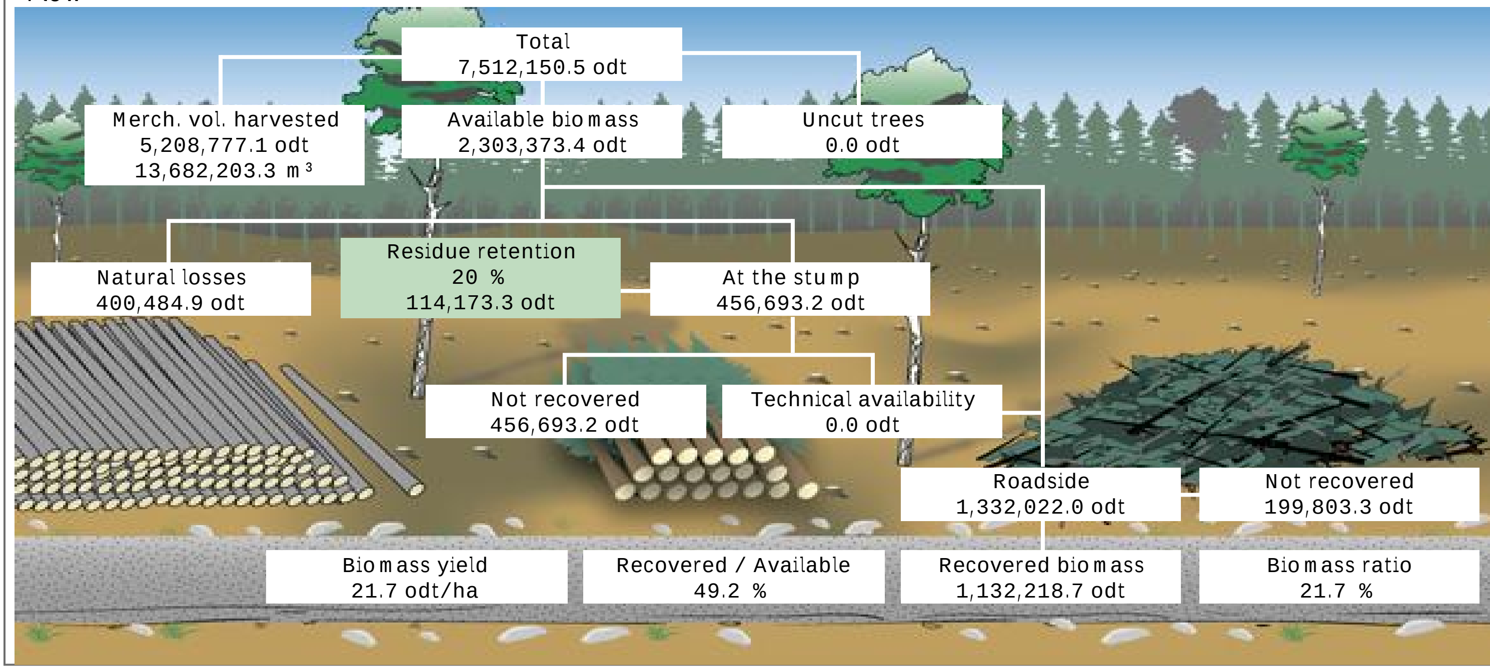
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

Profit	-63.44 $/odt

Flow



Products

Product name	odt	odt/m³	odt/ha
Douglas-fir (residues)	443,158.8	0.1505	8.50
Spruce (residues)	314,302.8	0.0859	6.03
Abies (residues)	114,445.0	0.0652	2.19
Pine (residues)	102,772.8	0.1272	1.97
Hemlock (residues)	77,097.5	0.0573	1.48
Cedar (residues)	73,883.1	0.0585	1.42
Oak (residues)	6,413.3	0.2311	0.12
Larch (residues)	145.4	0.0826	0.00
	1,132,218.7	0.0959	21.71

Recovery summary

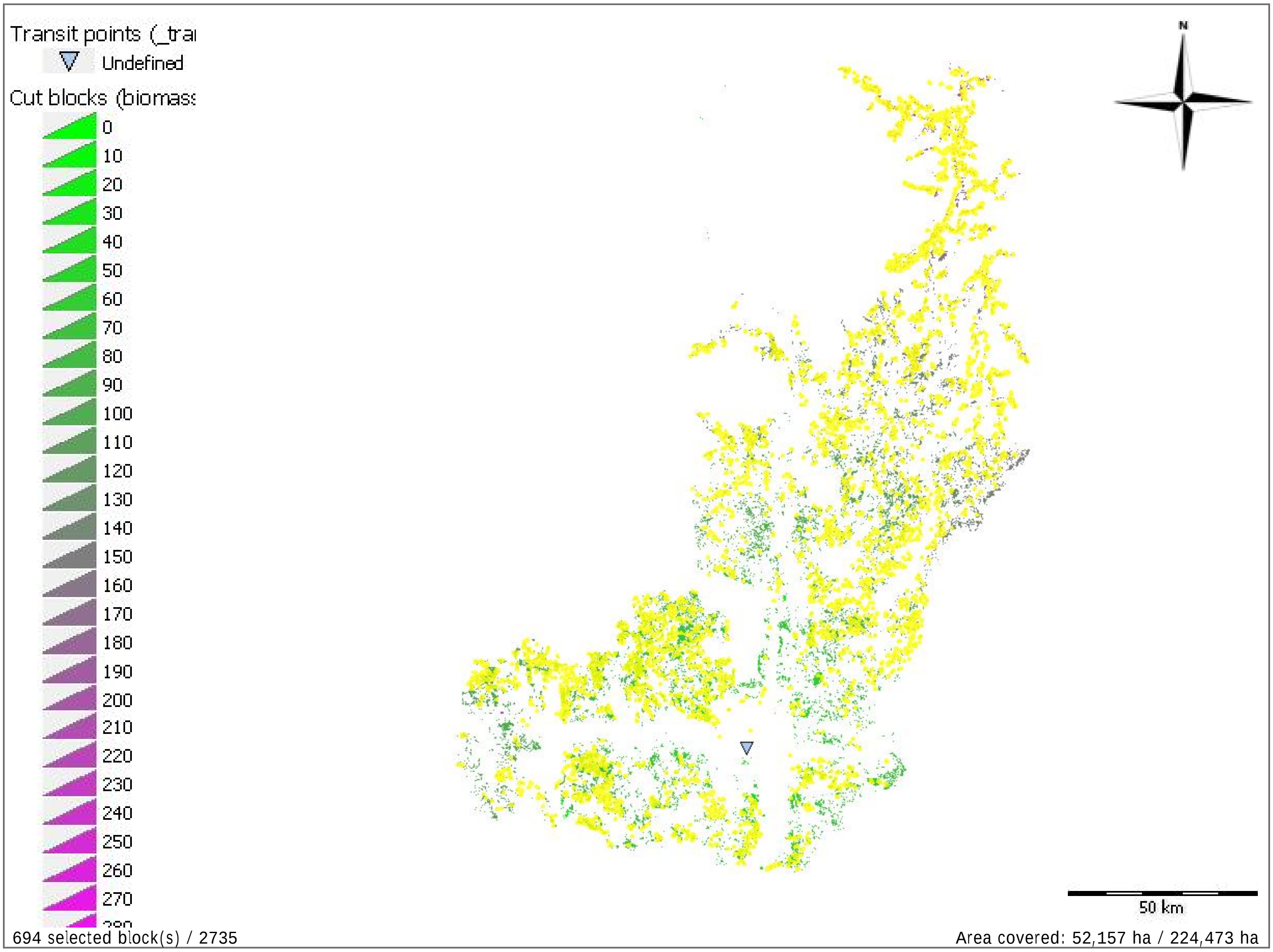
	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	1,132,218.7	52,156.8	694
• Recovery season			
Summer	0.0	0.0	0
Winter	1,132,218.7	52,156.8	694
• Residue freshness			
Fresh	0.0	0.0	0
Brown	1,132,218.7	52,156.8	694
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	0.0	0.0
40 $/odt	0.0	56,320.2	56,320.2
50 $/odt	0.0	265,063.3	265,063.3
60 $/odt	0.0	561,787.9	561,787.9
70 $/odt	0.0	784,229.6	784,229.6
80 $/odt	0.0	932,201.7	932,201.7
90 $/odt	0.0	1,028,552.6	1,028,552.6
100 $/odt	0.0	1,096,108.7	1,096,108.7
110 $/odt	0.0	1,121,019.8	1,121,019.8
120 $/odt	0.0	1,132,218.7	1,132,218.7
Maximum cost	0.00 $/odt	119.09 $/odt	

Delivery to mills

Destination	Product	Format	odt	Transport average distance (Km)
Domtar Mill				
	Abies (residues)	Chips	114,445	170
	Cedar (residues)	Chips	73,883	206
	Douglas-fir (residues)	Chips	443,159	91
	Hemlock (residues)	Chips	77,098	221
	Larch (residues)	Chips	145	172
	Oak (residues)	Chips	6,413	160
	Pine (residues)	Chips	102,773	86
	Spruce (residues)	Chips	314,303	153
			1,132,219	133
			1,132,219	133


Transit points (_tra
Undefined
Cut blocks (biomass
0
10
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90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
N
50 km
694 selected block(s) / 2735
Area covered: 52,157 ha / 224,473 ha

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	224,430.6 ha
Number of cut blocks	2734
Recovered biomass	4,902,101.4 odt
Biomass yield	21.8 odt/ha
Biomass odt / Merchantable m^3	0.0946 odt/m^3
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	30 : 1
Available energy	19,462,432 MWh
Fuel consumption	15.0 L/odt

Cost

Harvesting	0.00 $/odt
Biomass recovery	21.23 $/odt
Transfer yard	0.00 $/odt
Transportation	36.61 $/odt
Loading/unloading	0.00 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	1.11 $/odt
Indirect costs	0.00 $/odt
Total	58.94 $/odt

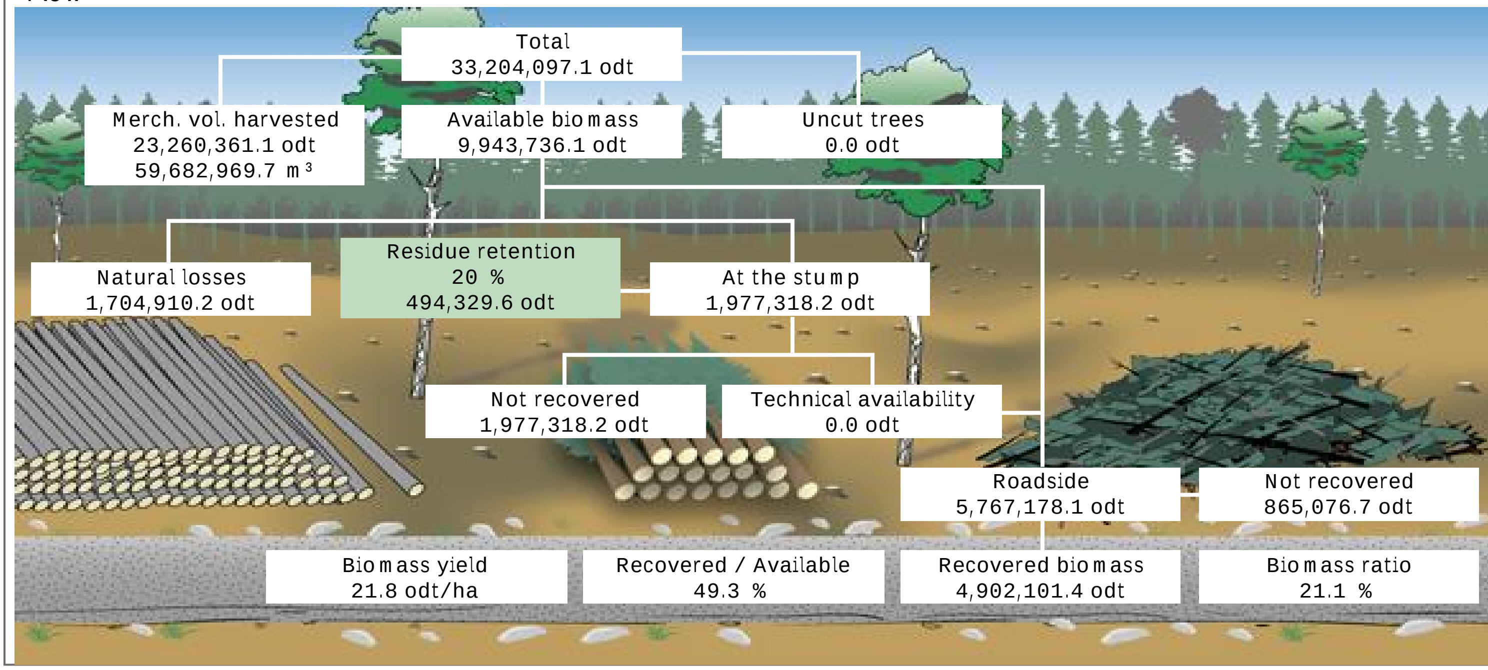
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

Profit	-58.94 $/odt

Flow



Products

Product name	odt	odt/m³	odt/ha
Douglas-fir (residues)	1,973,491.3	0.1364	8.79
Spruce (residues)	1,312,511.3	0.0874	5.85
Pine (residues)	695,351.7	0.0887	3.10
Abies (residues)	442,761.2	0.0682	1.97
Cedar (residues)	230,763.3	0.0586	1.03
Hemlock (residues)	224,534.1	0.0565	1.00
Oak (residues)	22,534.9	0.2269	0.10
Larch (residues)	153.7	0.0842	0.00
	4,902,101.4	0.0946	21.84

Recovery summary

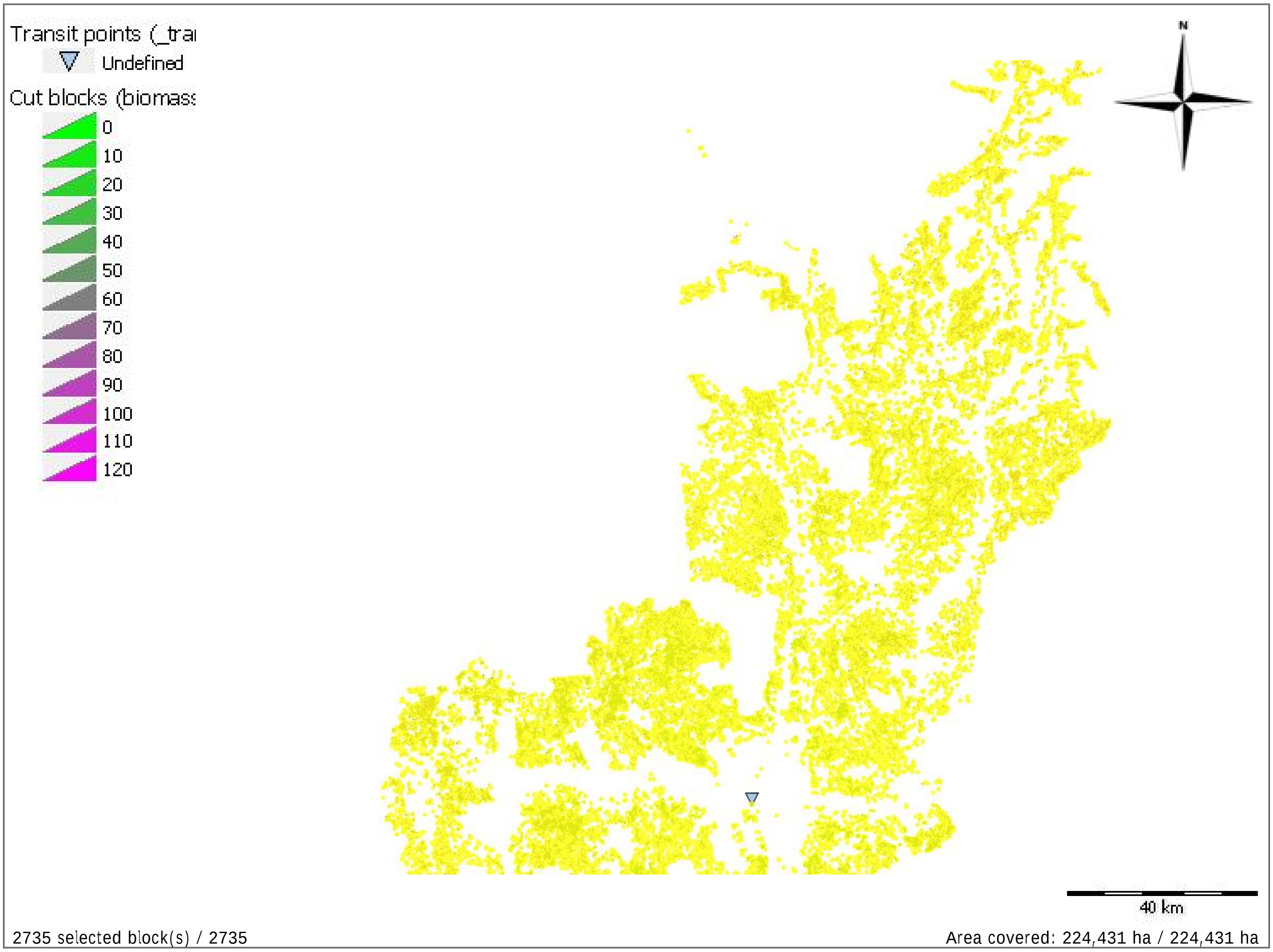
	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	4,902,101.4	224,472.7	2,735
• Recovery season			
Summer	0.0	0.0	0
Winter	4,902,101.4	224,472.7	2,735
• Residue freshness			
Fresh	0.0	0.0	0
Brown	4,902,101.4	224,472.7	2,735
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	1,006.3	1,006.3
40 $/odt	0.0	309,567.8	309,567.8
50 $/odt	0.0	1,584,738.9	1,584,738.9
60 $/odt	0.0	2,938,025.7	2,938,025.7
70 $/odt	0.0	3,810,608.7	3,810,608.7
80 $/odt	0.0	4,469,479.2	4,469,479.2
90 $/odt	0.0	4,691,152.8	4,691,152.8
100 $/odt	0.0	4,839,992.9	4,839,992.9
110 $/odt	0.0	4,890,902.6	4,890,902.6
120 $/odt	0.0	4,902,101.4	4,902,101.4
Maximum cost	0.00 $/odt	119.09 $/odt	

Delivery to mills

Destination	Product	Format	odt	Transport average distance (Km)
Domtar Mill				
	Abies (residues)	Chips	442,761	147
	Cedar (residues)	Chips	230,763	192
	Douglas-fir (residues)	Chips	1,973,491	85
	Hemlock (residues)	Chips	224,534	208
	Larch (residues)	Chips	154	168
	Oak (residues)	Chips	22,535	139
	Pine (residues)	Chips	695,352	93
	Spruce (residues)	Chips	1,312,511	130
			4,902,101	114
			4,902,101	114


Transit points (_trai
Undefined
Cut blocks (biomass
0
10
20
30
40
50
60
70
80
90
100
110
120
N
40 km
2735 selected block(s) / 2735
Area covered: 224,431 ha / 224,431 ha

Territory:	Unknown territory
Sector:	Unknown sector
Cut block:	<Multiple selection>

Statistics - Selected Items

Area	224,430.6 ha
Number of cut blocks	2734
Recovered biomass	4,902,101.4 odt
Biomass yield	21.8 odt/ha
Biomass odt / Merchantable m^3	0.0946 odt/m^3
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Residues	0 %
Energy balance	28 : 1
Available energy	19,462,432 MWh
Fuel consumption	16.4 L/odt

Cost

Harvesting	0.00 $/odt
Biomass recovery	25.89 $/odt
Transfer yard	0.00 $/odt
Transportation	36.61 $/odt
Loading/unloading	0.00 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance	1.11 $/odt
Indirect costs	0.00 $/odt
Total	63.61 $/odt

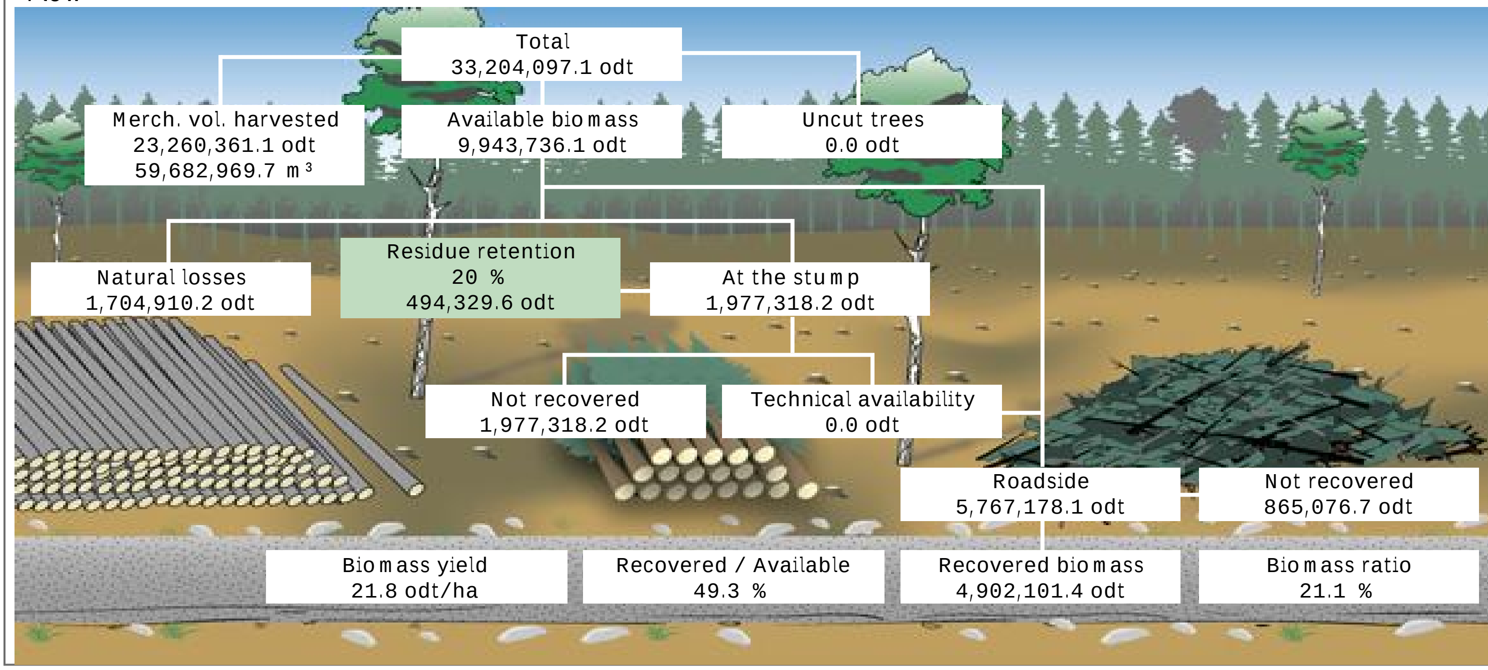
Revenue

Sale value	0.00 $/odt
Silvicultural discount	0.00 $/odt

Net

Profit	-63.61 $/odt

Flow



Products

Product name	odt	odt/m³	odt/ha
Douglas-fir (residues)	1,973,491.3	0.1364	8.79
Spruce (residues)	1,312,511.3	0.0874	5.85
Pine (residues)	695,351.7	0.0887	3.10
Abies (residues)	442,761.2	0.0682	1.97
Cedar (residues)	230,763.3	0.0586	1.03
Hemlock (residues)	224,534.1	0.0565	1.00
Oak (residues)	22,534.9	0.2269	0.10
Larch (residues)	153.7	0.0842	0.00
	4,902,101.4	0.0946	21.84

Recovery summary

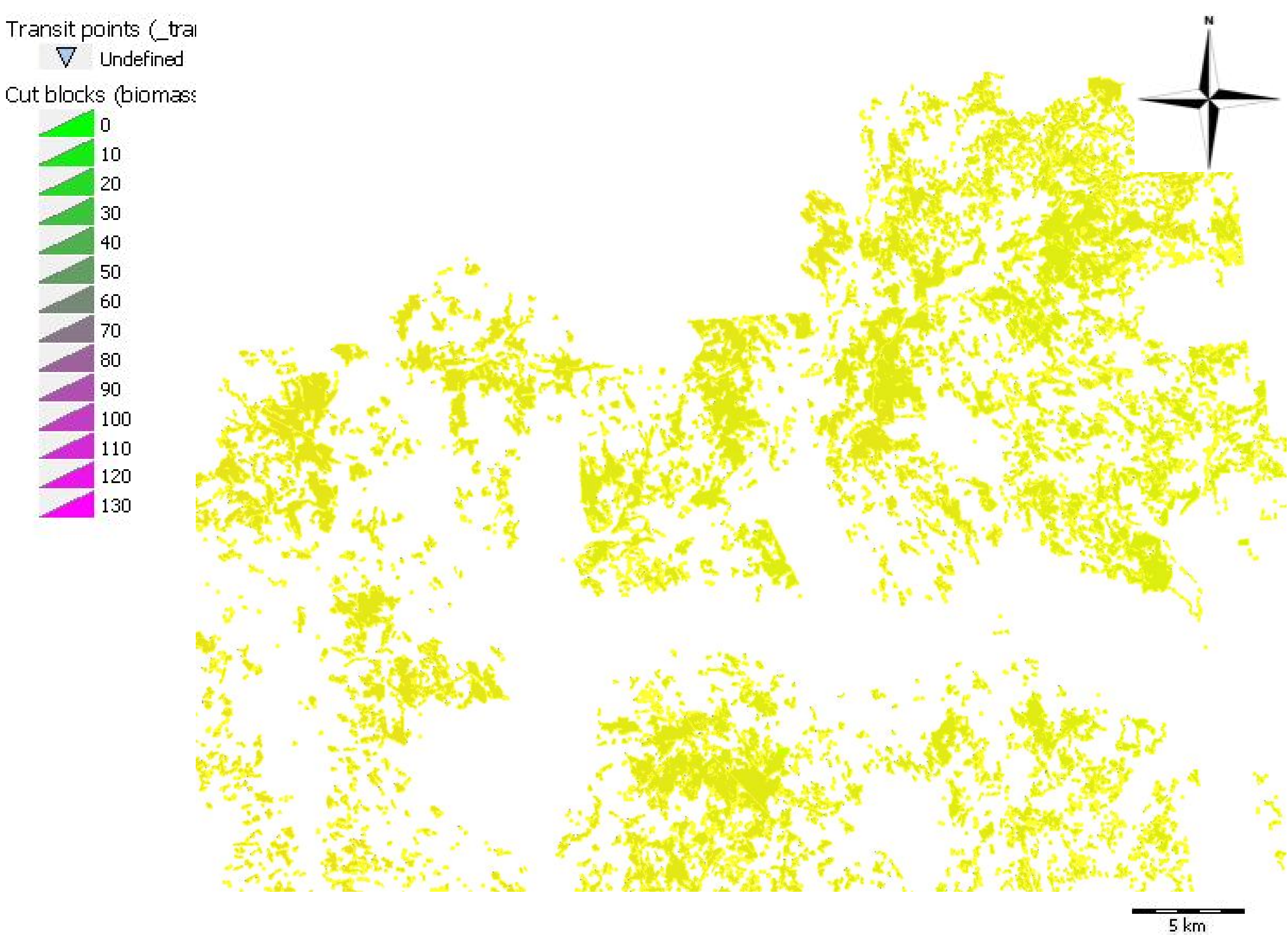
	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.0	0.0	0
Roadside	4,902,101.4	224,472.7	2,735
• Recovery season			
Summer	0.0	0.0	0
Winter	4,902,101.4	224,472.7	2,735
• Residue freshness			
Fresh	0.0	0.0	0
Brown	4,902,101.4	224,472.7	2,735
Brittle	0.0	0.0	0

Supply summary

Recovered biomass to	Merchantable volume (odt)	Residues (odt)	Total biomass (odt)
10 $/odt	0.0	0.0	0.0
20 $/odt	0.0	0.0	0.0
30 $/odt	0.0	598.1	598.1
40 $/odt	0.0	27,374.8	27,374.8
50 $/odt	0.0	836,377.3	836,377.3
60 $/odt	0.0	2,352,192.9	2,352,192.9
70 $/odt	0.0	3,380,868.5	3,380,868.5
80 $/odt	0.0	4,249,799.2	4,249,799.2
90 $/odt	0.0	4,592,927.3	4,592,927.3
100 $/odt	0.0	4,784,494.2	4,784,494.2
110 $/odt	0.0	4,874,581.1	4,874,581.1
120 $/odt	0.0	4,897,403.0	4,897,403.0
130 $/odt	0.0	4,902,101.4	4,902,101.4
Maximum cost	0.00 $/odt	123.76 $/odt	

Delivery to mills

Destination	Product	Format	odt	Transport average distance (Km)
Domtar Mill				
	Abies (residues)	Chips	442,761	147
	Cedar (residues)	Chips	230,763	192
	Douglas-fir (residues)	Chips	1,973,491	85
	Hemlock (residues)	Chips	224,534	208
	Larch (residues)	Chips	154	168
	Oak (residues)	Chips	22,535	139
	Pine (residues)	Chips	695,352	93
	Spruce (residues)	Chips	1,312,511	130
			4,902,101	114
			4,902,101	114



2735 selected block(s) / 2735

Area covered: 224,431 ha / 224,431 ha

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