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

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Abstract

Based on inventory information and a 20-year harvest queue, estimates of the amount of biomass produced from forest harvest residues are estimated in $10 increments of delivered cost. For the Quesnel Timber Supply Area, 85,000 odt/year is projected to be available at $60/odt for years 1-10.

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1. Executive summary

In 2011 FPInnovations used FPInterface to develop and demonstrate a method for estimating the availability of forest-origin biomass in British Columbia Timber Supply Areas: the Quesnel TSA was the test case. 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 Resources. Quesnel was designated as the delivery point in the primary analysis, and additional analyses were undertaken for delivery points at Williams Lake, Prince George, and Anahim Lake. Several analyses were undertaken to test the sensitivity of the biomass estimates to changes in fuel costs, annual operating hours, topping diameter of sawlogs, and slash freshness, and to test the sensitivity of excluding recovery of dead mountain pine beetle-attacked stands. All planned blocks were assumed to be clearcut harvested, processed at roadside, and accessible to comminution operations.

The total biomass delivered to the city of Quesnel over the Years 1 to 10 was projected to be 4.077 million ODT, and 850 000 ODT (or approximately 85 000 ODT/year) was available, at $60/ODT. The amount of biomass available in Years 11 to 20 was about 30 000 ODT/year, at $60/ODT. If the acceptable price of delivered biomass rises to $90/ODT the amount of available biomass would nearly triple for both time periods.

Little biomass from the Quesnel TSA was available to mills or centres outside of Quesnel for a lower cost than for delivering to Quesnel because the road system is optimized to Quesnel.

Some areas for improvement were identified, i.e., to enhance the established method of biomass estimation, including: establishing protocols for better data acquisition, alignment, cleaning, and aggregation; acquiring and inputing British Columbia biomass equations into FPInterface; and further enhancing and developing FPInterface in order to speed up the model's run time in future projects.

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 forest-origin biomass.

To address this need, FPInnovations developed 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 method for calculating biomass inventories in Timber Supply Areas in the Central Interior and then test that method on a forest region. The region chosen was the Quesnel Timber Supply Area (TSA).

The focus of this assessment was on economically available biomass. Previous assessments had reflected on total biomass availability, which had proven to be significantly greater than economically available biomass. In order to accomplish the goals of the project it was determined that the method for calculating biomass inventories would be based on a modelling tool called FPInterface, using its BiOS module. This tool has been under constant development since 1998. It contains forest productivity data in a database format usable by forest planners for scheduling and estimating the costs of some basic forestry activities. FPInterface's financial and equipment productivity data used together with the

MFLNRO's inventory and harvesting projections would allow the construction of a biomass inventory stratified by cost of delivery in terms of $10 increments per ODT (oven-dried tonne).

In initial meetings with the MFLNRO several key guidelines were established;

1. Repeatability of the method for other forest regions in British Columbia—The method must be repeatable in other forest regions in the province. As a result the project needed to be based on standard MFLNRO information that would be available for any forest region.
2. Sensitivity of the results—It was recognized early in the project that the results could vary depending on the "assumption" input. There must be the ability to test the sensitivity of these assumptions to help understand how the economically available biomass estimate could change.
3. Scale of the project—The goal of applying the method to the entire province was discussed, and there were concerns about the ability of the tool to handle such a large amount of data. The team decided to focus on delivering a biomass inventory at the TSA level or at the Tree Farm License (TFL) level.

Based on the discussions and these guidelines it was recognized that the Quesnel TSA could be a good fit for building the method. The Quesnel TSA offered several advantages:

1. The allowable annual cut (AAC) determination had recently been completed, so the data from the MFLNRO had had a detailed review.
2. The region had been hit heavily by the mountain pine beetle infestation, so the analysis could take into account standing dead trees.
3. The region is in the Central Interior, which is the focus area of the British Columbia Central Interior Initiative.

Project work started in January of 2011, after an initial meeting of the partners, and was concluded by the end of March. In January through February the project focused on managing the data and getting it into FPInterface in a usable format, while March focused more on sensitivities and scenario analysis.

3. Objectives

A. Develop a method for calculating biomass supply in specific geographic areas of British Columbia.
B. Identify issues requiring further resolution, within the method and/or arising from the method.
C. Calculate biomass supply for volume-based tenures in the Quesnel TSA. The desired outputs are:
    1. A map showing delivered cost of biomass from point of origin, by cost gradation.
    2. A table showing the amount of biomass delivered at different price points. The market value of 1 ODT of biomass was not clear, but $60/ODT was set as the agreed-upon threshold at which to determine the commercial availability of biomass.
    3. Tests of the sensitivity of the results to key inputs.
    4. Tests of two specific scenarios:
        - optimizing delivery to Prince George, Williams Lake, and Anahim Lake, where these are cheaper than delivery to Quesnel
        - 20-year harvest forecast compared to the baseline 10-year forecast

4. Methods

Overview

The flow chart in Figure 1 shows the steps taken to build the final inventory of economically available biomass.

After this process was undertaken, a meeting was held in mid-March and some areas of opportunity were identified for improving the method. A key outcome of the discussion was the ability to eliminate the species column translation step.

Economically Available Biomass Inventory Development Process

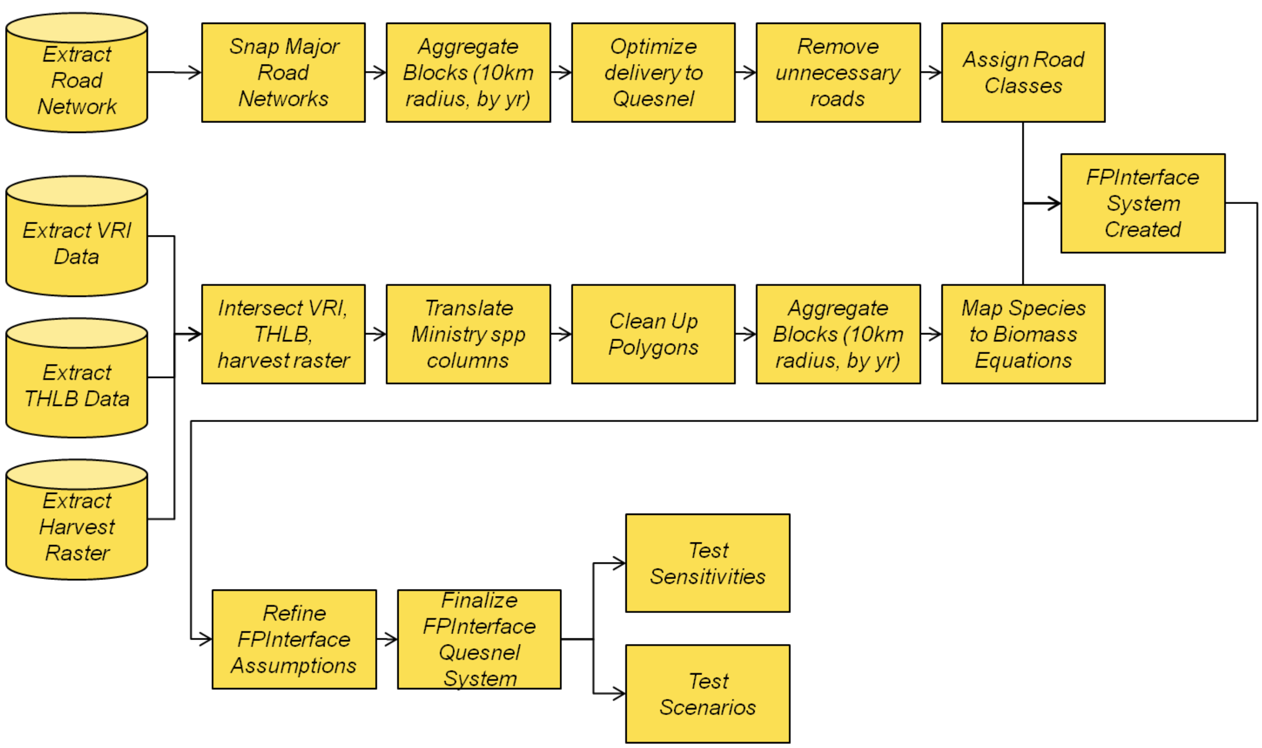

Figure 1. Steps taken to build the final inventory of economically available biomass.

Data acquisition

Data layers for the Quesnel TSA (excluding Woodlot Licenses, Tree Farm Licenses (TFL), Community Forest Agreements, and First Nations tenures) were acquired from MFLNRO. The data included Vegetation Resources Inventory polygons with attributes, timber harvesting land base (THLB) polygons and proportions, and road linework with attributes. The MFLNRO also supplied a 20-year harvest raster.

The 20-year harvest raster is a point-in-time snapshot. It indicates which polygons are expected to be harvested in each of the 20 years. No attempt was made to model possible growth or mortality during the 20-year horizon. Any projections of growth or mortality were represented as fixed in the harvestable proportion contained in the THLB data.

Data transformation

FPInterface requires two major inputs—a polygon layer of harvestable blocks with attributes, and a road layer. To acquire the appropriate polygon layer, the Vegetation Resources Inventory, THLB, and harvest raster were intersected. The resultant had more than 60 000 polygons. This slowed the operation of FPInterface: some functions required more than an hour to perform, with some outputs requiring several hours.

To calculate biomass FPInterface requires tree size data (height and dbh), plus either stand density (no. stems/ha) or volume (m^3/ha) by species in each polygon. When the polygon layer is uploaded it is necessary to associate the species in the resultant to the species present in FPInterface. The attribute table of the dataset did not have columns of species information by species, e.g., there was not a set of lodgepole pine columns. Rather, each polygon had a set of leading species columns and then a set of second species columns, etc. It was necessary to sort the columns into species groups before further analysis could be conducted. This took a significant amount of time, and in the March meeting the MFLNRO confirmed it could provide a dataset that would not require this translation.

In order to increase the speed of calculation, polygons with little or no merchantable volume were targeted for elimination. Polygons with no volume, having an average piece size <0.15 m^3, or being <0.5 ha in size were removed from the resultant. Some of these polygons resulted from the process of intersecting the Vegetation Resources Inventory, THLB, and the harvest raster layers. Removing these polygons caused a reduction in net volume of <4%.

The performance of FPInterface was further enhanced by aggregating blocks in order to reduce the number of calculations required to find spatial paths between product origins and mills. Aggregation rules grouped blocks of identical harvest year and within a 10 km radius. The performance of FPInterface improved noticeably such that most functions required <5 min and with none longer than 30 min[1].

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 may find a suboptimal, circuitous path. Examination of the dataset showed that a great deal of road snapping was required.

Road snapping was addressed but initial runs of the data in FPInterface nevertheless produced error messages, and significantly long processing times were encountered. Snapping began on mainlines and proceeded to lower grade and more distant roads. Once a large number of roads had been snapped, a run was processed and FPInterface's "Display/Transiting Volumes – Merchant" tool was employed to show roads in use by the system (and the amount of volume transited on each road).

[1] Using an i7 processor with a solid state drive

Roads that did not access blocks and did not cause circuitous routing were eliminated from the dataset. This allowed road snapping to be more focussed and helped speed up calculation runs.

Biomass equations

The species included in FPInterface are tied to biomass equations. These equations are based on the published "Canadian national tree aboveground biomass equations" (Lambert et al. 2005). 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 Ung et al. (2008) have released tree equations for British Columbia and the MFLNRO has also provided FPInnovations with biomass data by biogeoclimatic ecological classification zone (BEC), which can be incorporated into future projects.

Concern over the possible inaccuracy of using Western Canadian equations instead of specifically British Columbia equations was tested by examining the biomass ratio (the ratio of recovered biomass to recovered merchantable roundwood).

For converting volume in m^3 to ODT for mixed species results, a conversion factor of 2.5 was used. Sample data from the Quesnel TSA were tested in BiOSMatrix™, a non-spatial biomass predictor. BiOSMatrix uses British Columbia tree equations (Standish et al., 1985). Because the BiOSMatrix outputs of biomass ratio approximated those of FPInterface, the results of FPInterface are thought to be reasonably accurate for the Quesnel TSA. Nevertheless, FPInterface equations should be updated with British Columbia equations as soon as feasible.

FPInterface parameters for the base case

Tree species associations

The dataset contained tree species as polygon attributes. These species must be associated with FPInterface biomass equations. As mentioned above, not all species were represented by British Columbia biomass equations; for example, there are no equations for Douglas-fir. A reasoned examination of the characteristics of interior Douglas-fir compared to the accepted averages for British Columbia species tree parameters led to utilization of interior lodgepole pine equations for interior Douglas-fir. Species associations were made as follows in Table 1.

Table 1. Tree species associations

Vegetation resources inventory	FPInterface biomass equation
balsam poplar	balsam poplar
cottonwood	other poplars
trembling aspen	trembling aspen
subalpine fir	alpine fir
amabilis fir	alpine fir
western redcedar	cedar
white birch	white birch
Douglas-fir, interior	lodgepole pine
western hemlock	hemlock
tamarack	larch
western larch	larch
lodgepole pine	lodgepole pine
spruce	white spruce
white spruce	white spruce
Engelmann spruce	white spruce
Sitka spruce	white spruce
hybrid spruce	white spruce
black spruce	black spruce

Road classes

The road dataset contained road class names that could be associated with road classes in FPInterface. FPInterface road classes could then be assigned speeds based on truck configuration. The hauling of comminuted fibre was assigned to 3-axle chip trucks, and the hauling of logs was assigned to B-train logging trucks. One set of speeds was assigned regardless of truck configuration; then, following the methodology in the *Interior Appraisal Manual*, 95% of the assigned road speed was set for empty haul and 85% for loaded haul. Road classes and speed were assigned as indicated in Table 2. All roads were assumed to be accessible for biomass operations.

Table 2. Road class associations

Road class		Road speed		
MFLNRO	FPInterface	Posted speed (km/h)	Empty haul [a] (km/h)	Loaded haul [b] (km/h)
Highway	Paved	90	86	77
Arterial	Class 1	70	67	60
Collector	Class 2	50	48	43
Local	Class 2	50	48	43
Ramp	Class 3	40	38	34
Other	Class 3	40	38	34
Resource	Class 3	40	38	34
Lane	Class 5	20	19	17
Recreational	Class 5	20	19	17
Restricted	Class 5	20	19	17
Service	Class 5	20	19	17
Strata	Class 5	20	19	17

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

General parameters

The price of fuel can have significant impacts on the model's results. Some equipment in the model can use diesel and while other equipment is eligible for marked fuel. A price of $1.25/L was assigned, which was near to commercial rates for diesel at the time, but was slightly higher than the price of marked fuel. Although no attempt was made to forecast a long-term fuel rate (10 to 20 years), sensitivity to $2 fuel was tested.

The program's default values for productivities and costs of forestry equipment rely on a long history of FPInnovations studies and on other information gathered by FPInnovations. If an operator has specific values or costs they wish to apply to any phase or machine these can be used instead of the defaults. For this project 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.

Working time for British Columbia conditions was based on one 10-h shift/day, 180 days/year. 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 1 (very good), and ground roughness was rated as CPPA Class 1 (very even).

Biomass parameters

Most roads and mainlines in the Quesnel TSA lead to the city of Quesnel so it was selected as the default location for biomass delivery.

Forest-origin comminuted fibre is usually the byproduct of harvesting residues. This analysis assumed all cutblocks were clearcut harvested with stems processed at roadside. Partial harvests or in-block processing would reduce the amount of biomass available for roadside comminution. To reflect typical British Columbia practice as observed by FPInnovations, program parameters included pre-piling forest residues at roadside and followed by comminution in a medium-sized (600-kW) grinder. This grinder was chosen because it had the most relevant (for British Columbia) productivity data available in the tool. Mill residues were not included in this project.

The harvesting of standing trees for biomass purposes is generally considered uneconomic in British Columbia because their recovery must cover the full costs of planning and developing and the harvesting of stands, in addition to the costs for biomass recovery operations. However, because of mortality due to mountain pine beetle infestation, some whole logs were included for biomass chipping. Although the THLB proportion attribute includes mortality attributed to mountain pine beetle, because of ongoing attack by the beetle and the degraded state of mountain pine beetle logs, 30% of lodgepole pine volume was removed from availability as merchantable volume. Half of this (15% of total lodgepole pine volume) was estimated to become available for whole-log chipping or grinding at roadside, and the remainder was counted as loss.

The standard British Columbia utilization specifications for the Interior are a 30-cm-high stump and a 10-cm-diameter top. However, field observations by FPInnovations staff indicate that tops of 12.5 to 15 cm are more common in practice despite the possibility of waste billing penalties. A 13-cm topping diameter was used for the base case.

Given that the majority of Interior harvesting occurs in winter, this season was selected for comminution. Three levels of slash freshness are available in FPInterface, reflecting varying amounts of material loss. Fresh (0 to 3 months) was used for the base case.

It is also possible in FPInterface to attribute indirect costs to both harvesting and biomass phases. These include costs for administration, forest camps, low-bedding, etc. Initially we used the Eastern averages of $7.07/m^3 for harvesting and $7.92/ODT for biomass. However on closer examination, the methodology in the *Interior Appraisal Manual* includes indirect costs in its listed equipment rates. Therefore, these additional indirect costs were dropped because machine costs and productivities contained in FPInterface were found to approximate the rates in the *Interior Appraisal Manual* once British Columbia conditions were accounted for in the modelling tool.

Scenarios and sensitivities

In addition to the base case described above, several scenarios were developed and analyzed, in order to test sensitivity of the outputs to changes in conditions.

Mill location

Although most roads in the Quesnel TSA lead to the city of Quesnel, other fibre mills exist in the vicinity and scenario runs were performed to some of these locations, specifically Williams Lake, Prince

George, and Anahim Lake. Anahim Lake is not on the power or rail grid, and therefore may support a higher delivered cost for biomass. However, exporting any excess electricity from Anahim Lake would require a transmission grid at an estimated cost of $2 million to 3 million/km (Ng, 2009). Functionality exists in the program to optimize transport based on lowest cost to all mills specified. However, the version created to enhance performance for the Quesnel dataset contained a bug that caused this feature to malfunction. Separate runs were therefore performed to each mill location.

Time frame

The data identified 20 years of harvest. An examination of both the merchantable output and the hectares identified for harvest showed that a significant falldown is projected for Years 11 to 20. Originally it was thought that the base case should project biomass supply for the entire 20-year horizon; however, considering the falldown, it was reasoned that the higher fibre supply available in Years 1 to 10 represents more historically normal conditions. Accordingly the base case was adjusted for a 10-year amortization and the 20-year period was run as a scenario.

Fuel at $2/L

Given the volatility in fuel prices in recent years, sensitivity to a higher average fuel price of $2/L was tested. This price was applied equally to trucking, harvesting, and biomass phases.

Working time

The program proved sensitive to changes in the input values for working time; namely, number of hours/shift and number of days worked/year. These affect costs by changing the amount of work that can be accomplished in a given time frame and by changing the length of time over which to amortize machinery costs. Separate scenarios were run, adjusting working time to 12 hours/day and to 200 days/year.

Slash freshness

In the nascent biomass industry in British Columbia, most biomass comminution takes place within the first few months after harvest. This means that little material is lost or degraded after pre-piling. Slash freshness settings in FPInterface include “fresh” (0 to 3 months old), “brown” (3 to 24 months old), and “brittle” (>24 months old). There is some evidence that as hog ages it may decrease its moisture content, in the right conditions. Although there is some material loss, there is a trade-off in reduced hauling costs ($/GJ). As the industry matures, grinding may take place later, therefore sensitivity to slash freshness of “brown” was tested.

Topping diameter

Instead of using the 13-cm topping diameter, we tested a topping diameter reflecting the regulated 10 cm.

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

The base case removed 30% of lodgepole pine volume because of loss due to the mountain pine beetle infestation. Half of this (15%) was considered available for biomass use. A scenario was run in which there was no loss due to mountain pine beetle (beyond what is already accounted for in the THLB), and another in which 30% was lost but none of the stems became available for biomass (Table 3).

Table 3. Utilization of mountain pine beetle-affected stems: scenarios

Scenario	Stems converted to merchantable logs (%)	Stems converted to biomass (%)	Stems unutilized (%)
Base case	70	15	15
No loss due to mountain pine beetle	100	0	0
No biomass recovered from mountain pine beetle	70	0	30

Biomass calculations

The biomass calculations in FPInterface produce an amount 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 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 for the numbers from the 10-year base case.

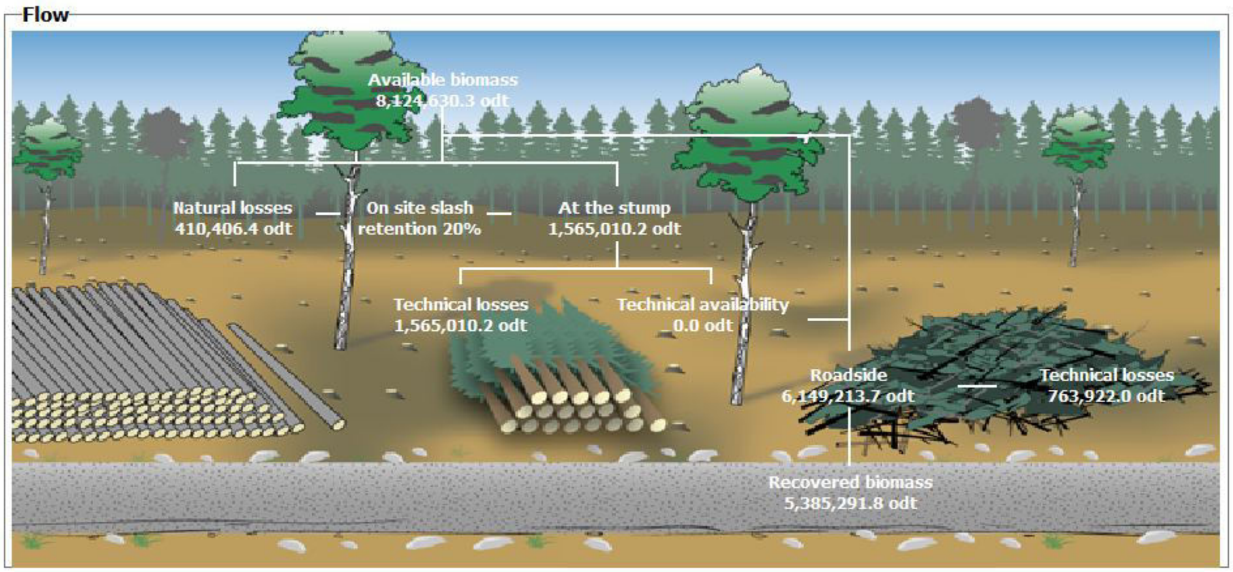

Figure 2. Recoverable biomass: 10-year base case.

5. Results and discussion

Summary—key results from the base case and scenarios

Key results from the 10-year base case and other scenarios are summarized in Table 4. More detailed results are available below and in Appendix 1. A more complete listing of parameters and outputs of the different scenarios can be found in Appendix 2.

Table 4. Key results

Scenario	Recovered biomass			Highest delivered biomass cost (from slash) ($)	Biomass ratio (%)	Change to base case input (%)	Change in cost (%)	Change in recovered biomass at $60/ODT (ODT)
	Total (ODT)	At $60/ODT (ODT)	At $90/ODT (ODT)					
10-year base case	4 077 344	858 541	2 361 977	148.76	42.4	--	--	--
Mill: Williams Lake	4 077 344	11 197	906 371	156.87	42.4	n/a	▲ 5	▼99
Mill: Prince George	4 077 344	0	712 307	180.18	42.4	n/a	▲ 21	▼ 100
Mill: Anahim Lake	4 077 344	0	71 242	207.97	42.4	n/a	▲ 40	▼ 100
20-year harvest	5 385 292	1 154 526	3 078 681	148.76	41.0	n/a	0	▲ 34
Fuel at $2/L	4 077 344	370 689	1 808 247	172.14	42.4	▲ 60	▲ 16	▼ 57
12-h shift	4 077 344	1 148 529	2 632 443	136.18	42.4	▲ 20	▼ 8	▲ 34
200-day year	4 077 344	1 040 898	2 604 877	141.21	42.4	▲ 11	▼ 5	▲ 21
Slash freshness: 3 to 24 months	3 671 881	737 076	2 023 637	148.76	38.2	▼ 50	0	▼ 14
10-cm top diameter	3 705 367	719 923	1 995 352	148.76	38.5	▼ 23	0	▼ 16
No stems for biomass	3 176 971	929 822	2 634 291	148.76	26.7	▲ 23	▼ 25	▲ 8

No biomass recovered from mountain pine beetle losses	2 576 354	804 184	2 156 572	148.76	26.8	▼ 15	▼ 26	▼ 6

Base case

Some of the more significant settings in FPInterface for the 10-year base case are included in Table 5.

The base case run showed that 858 541 ODT are available at the Quesnel mill in Years 1 to 10 at a cost of no more than $60/ODT. The available amount nearly triples to 2.36 million ODT at $90/ODT. The total amount of biomass available at any price from the base case is 4 077 344 ODT.

For the present it appears unlikely that Canadian or North American markets would bear biomass prices of $90/ODT even though some other jurisdictions like Sweden support hog fuel prices in excess of $120/ODT (Cdn dollars). Unserviced (off the electric grid) locations in Canada, like Anahim Lake, might be willing to pay more for hog, and the idea that Canadian hog prices could rise is not infeasible.

Annualized, the base case shows that approximately 85 000 ODT/year from harvest residue could become available in Quesnel during Years 1 to 10, provided it is not already fully or partially allocated. During the succeeding 10 years (Years 11 to 20), only 295 985 ODT or about 30 000 ODT/year would be available given the post-mountain pine beetle falldown harvest which is projected by MFLNRO.

The biomass ratio for the base case is 42.4%. This is higher than is usually predicted for harvest residues because 15% of lodgepole pine stems were designated for biomass. If only the slash (harvest residues—no stems) is used to produce biomass, then the biomass ratio becomes 26.8%. Based on other FPInnovations studies, this is a typical number and a good predictor of the amount of biomass that can be recovered from roadside harvesting in the Central Interior.

At the interim presentation made to the MFLNRO on March 8, 2011, the available volume at $60/ODT was thought to be only about a quarter of that presented here. The results increased for a number of reasons: a better road network with more snapped roads and more available routes was developed, a program bug that limited the impact of increased topping diameter was fixed, and an improved regime of linking Vegetation Resources Inventory species to FPInterface species biomass equations was implemented.

An isometric map of hog fuel costs is shown in Figure 3, and a cost-availability table (in $10 increments), is in Table 6; see also Appendix 1.1. The “full stem” is biomass from mountain pine beetle stems and the “forest residues” is biomass from tops and branches. The “residues” wood is cheaper because the costs of harvest are applied to merchantable stems. For biomass from “full stems” all costs of harvest are applied to biomass (instead of being written off against roundwood making it much more expensive.

The cost-availability table (Table 6) shows that purpose-harvested wood for biomass is not economic at market prices for hog of \$60/ODT or even \$90/ODT.

The output report for the base case (Appendix 1.1a) shows that comminution costs average \$31.80/ODT. For the forest residues (slash) component, the remainder of the costs are transport costs. For the full stem (merchantable stems) component, the average harvest cost is \$73.88/ODT[2], comminution costs are \$31.80/ODT, and transport costs make up the balance.

In Figure 4 the graph of available biomass shows bimodal (two-hump) distribution. The first mode is biomass from forest residues (slash), the second mode reflects full stems from mountain pine beetle-affected lodgepole pine (merchantable wood).

[2] \$22.52 × 4 077 344 ÷ 1 242 895

Table 5. FPInterface parameters: 10-year base case

Run descriptor	Base case
run name	ques 23mar2011
transfer yards	Ques, PG, WL, Anahim
year(s) analyzed	1–10
species attribute linking	western
haul speeds	graduated
haul speeds at 95% / 85% of posted	y
transport shifts / day	1
transport hours / shift	10
transport days / year	180
transport fuel price / L	$1.25
average slope	20–32
slash used for biomass	y
full stem used for biomass	n
Pl utilization of THLB merch timber (%)	70
PL unutilized merch used for biomass (%)	15
Pl stems for biomass chipped where?	roadside
Pl merch stemwood for biomass directed where	Quesnel
chips destination	Quesnel
topping diameter (cm)	13
truck used for chips	3-axle
truck used for logs	B-train
harvesting fuel price / L (x3)	$1.25
harvesting shifts / day (x3)	1
harvesting hours / shift (x3)	10
harvesting days / yr (x3)	180
harvesting system	full tree
on site biomass treatment (roadside)	comminution
recovery season	winter
slash freshness	fresh
slash pre-piled at roadside	y
grinder size type	horizontal 600 kW
biomass fuel price / L (x2)	$1.25
biomass hours / shift (x2)	10
biomass shifts / day (x2)	1
biomass days / yr (x2)	180
indirect costs - biomass ($ value)	$0.00
indirect costs - harvesting ($ value)	$0.00

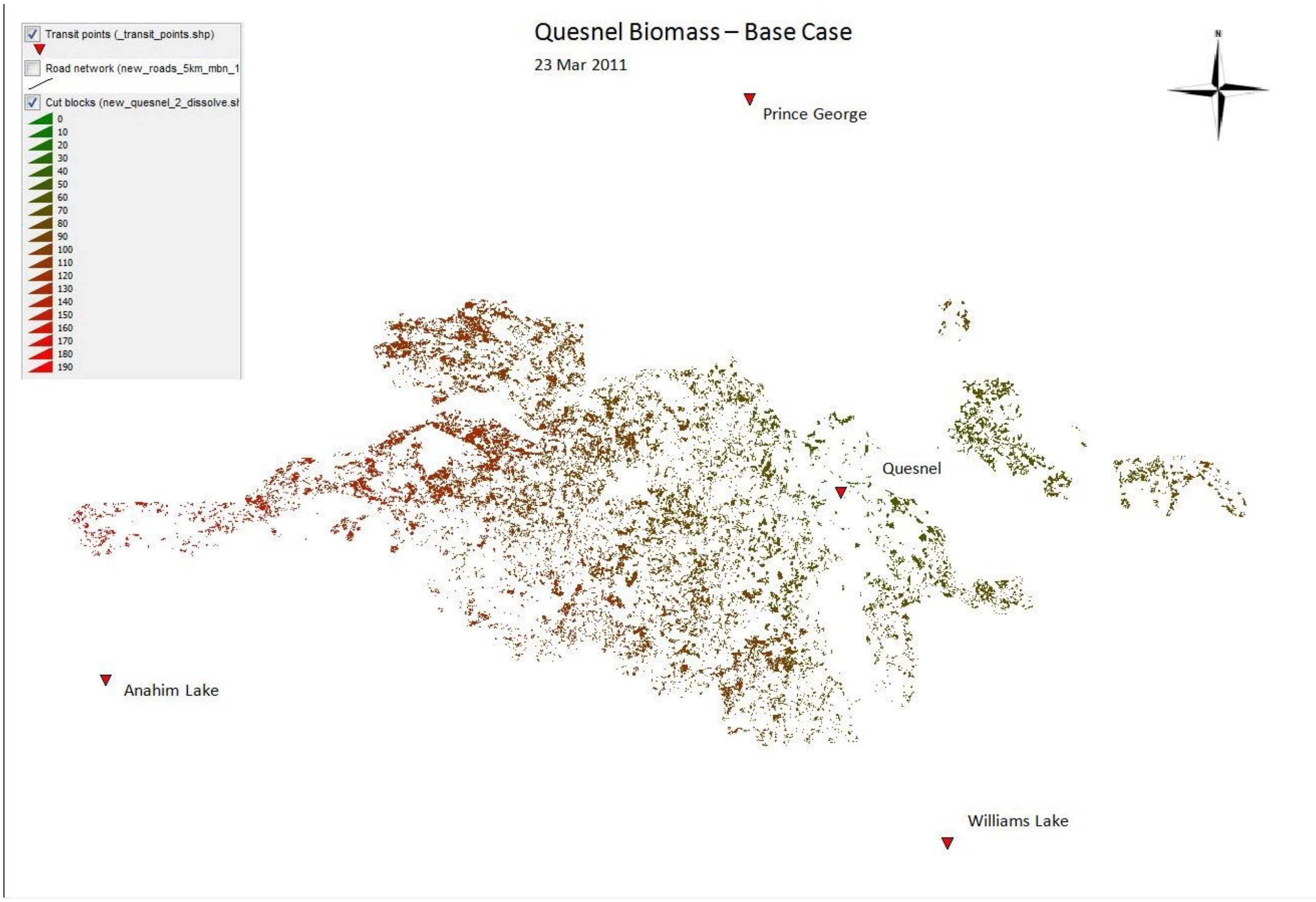

Figure 3. Cost of delivered biomass to the Quesnel mill from point of origin, in increments of $10/ODT: 10-year base case. The cost of biomass from roadside residues is averaged with the cost of biomass obtained from mountain pine beetle stems. Blocks closest to Quesnel have the lowest delivered costs and are the greenest. Blocks at the extremes of the TSA are the most expensive and the reddest in colour.

Table 6. Cost-availability, delivery to Quesnel: 10-year base case[a]

Supply summary

Recovered biomass to	From full stem (odt)	From forest residues (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	1,164.15	1,164.15
50 $/odt	0.00	226,613.22	226,613.22
60 $/odt	0.00	858,541.44	858,541.44
70 $/odt	0.00	1,375,861.93	1,375,861.93
80 $/odt	0.00	1,964,326.30	1,964,326.30
90 $/odt	0.00	2,361,977.11	2,361,977.11
100 $/odt	165.43	2,646,513.50	2,646,678.92
110 $/odt	12,537.77	2,724,434.98	2,736,972.75
120 $/odt	61,271.42	2,763,206.80	2,824,478.21
130 $/odt	186,960.66	2,800,700.00	2,987,660.66
140 $/odt	341,416.42	2,809,839.67	3,151,256.09
150 $/odt	537,852.10	2,834,448.91	3,372,301.00
160 $/odt	788,376.05	2,834,448.91	3,622,824.96
170 $/odt	986,569.21	2,834,448.91	3,821,018.12
180 $/odt	1,107,722.99	2,834,448.91	3,942,171.89
190 $/odt	1,169,603.05	2,834,448.91	4,004,051.95
200 $/odt	1,196,596.85	2,834,448.91	4,031,045.76
210 $/odt	1,220,419.66	2,834,448.91	4,054,868.57
220 $/odt	1,225,345.86	2,834,448.91	4,059,794.77
230 $/odt	1,232,800.12	2,834,448.91	4,067,249.02
240 $/odt	1,242,459.96	2,834,448.91	4,076,908.86
250 $/odt	1,242,598.90	2,834,448.91	4,077,047.81
260 $/odt	1,242,747.63	2,834,448.91	4,077,196.53
270 $/odt	1,242,865.25	2,834,448.91	4,077,314.16
280 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
290 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
300 $/odt	1,242,894.77	2,834,448.91	4,077,343.68
Maximum cost	**291.17 $/odt**	**148.76 $/odt**	

[a] The amount of biomass delivered to Quesnel is divided into $10 increments based on delivered cost.

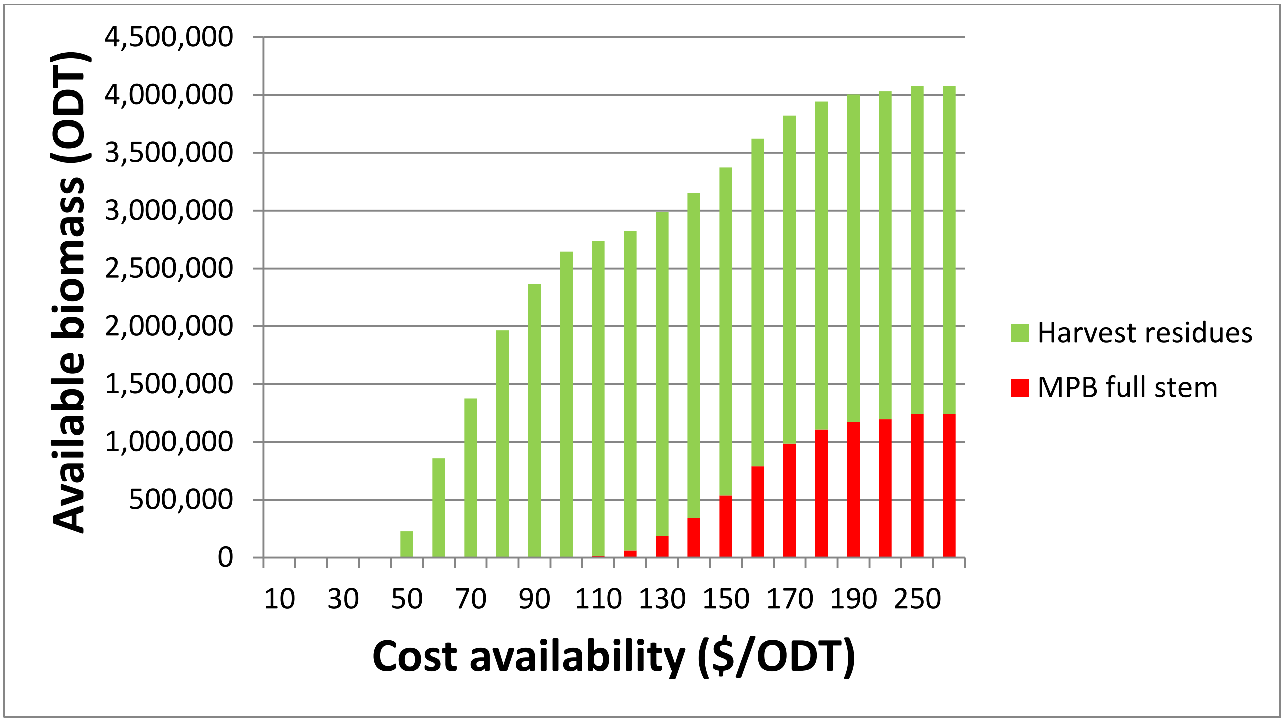

Figure 4. Cost availability of biomass delivered to the Quesnel mill: 10-year base case.

Other mill locations

Of the four available mills-i.e., at Quesnel, Williams Lake, Anahim Lake, and Prince George—the Quesnel mill was found to be the cheapest delivery point for 3.85 million ODT or (94.4% of the volume). Another 220 000 ODT (5.4%) were cheapest when directed to Anahim Lake, and 8 000 ODT (0.2%) were best directed to Williams Lake. No volume was cheapest when delivered to Prince George.

All volume up to $60/ODT was directed to Quesnel, except for 195 ODT optimized to Williams Lake. At $90/ODT most volume was again directed to Quesnel, with 8 000 ODT going to Williams Lake and 2 900 ODT to Anahim Lake.

The isometric cost map (Figure 5) for this scenario was generated outside of FPInterface, due to the malfunction with the mill optimization feature. Prince George is represented by the Canadian Forest Products mill, Quesnel is represented by the West Fraser mill, Anahim Lake is represented by the West Chilcotin mill, and Williams Lake is represented by the Tolko mill. The cost of delivering biomass from a block is optimized to the nearest mill. Optimization to the Dunkley Mill just north of Quesnel is unlikely to deliver results much different than those presented. Results of the individual runs to the three mills are in Appendices 1.1, 1.2, and 1.3.

A fifth location was considered near the centre of the TSA (west of Quesnel). The goal was to identify a location that could use the western biomass but minimize transport costs. Unfortunately this scenario marginally decreased economically available biomass. This was due to the road network in the Quesnel TSA. The roads tend to funnel to three or four mainlines that run predominantly east/west to Quesnel.

In the western half of the TSA there are no north/south roads crossing the rivers between the mainlines. As a result most biomass in this scenario had to cycle through Quesnel and then back out to the facility in the west. Further work on this scenario, including examining the possibility of adding north/south connectors, should be considered in the future.

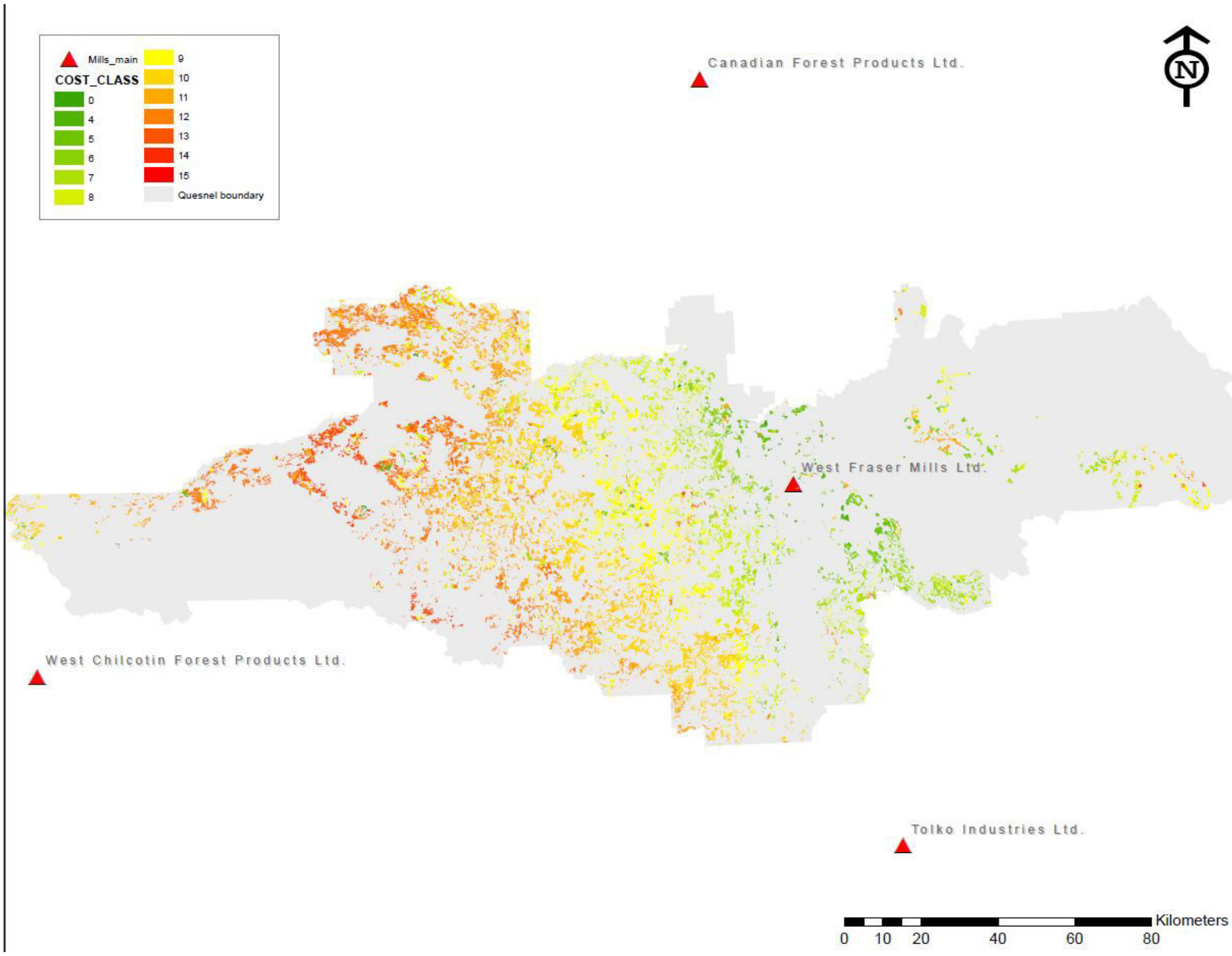

Figure 5. Multi-mill cost map. (cost class × $10 = cost of delivered biomass).

Twenty-year harvest scenario

Although more total volume is available at $60/ODT in the 20-year harvest scenario, at an annualized rate, the biomass availability drops from 85 000 ODT/year in Years 1 to 10 to 30 000 ODT/year in Years 11 to 20. Figure 6 depicts the annualized biomass predictions and the falldown in available volume over the 20-year horizon. The falldown is most pronounced in the final 6 years of the horizon. The falldown is caused by a reduction in available lodgepole pine due to infestation by mountain pine beetle. The total available volume over the 20-year horizon in $10 increments of delivered cost is shown in Table 7.

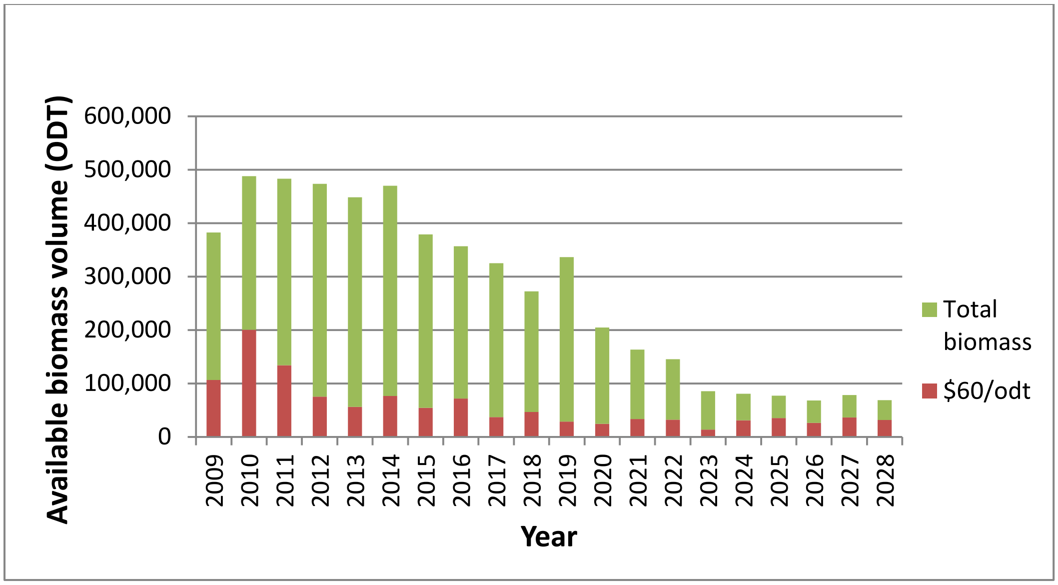

Figure 6. Available biomass volume, Quesnel mill, by year: 10-year base case, trial scenario.

Table 7. Cost-availability, delivery to Quesnel: 20-year scenario[a]

Supply summary

Recovered biomass to	From full stem (odt)	From harvest residues (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	2,061.80	2,061.80
50 $/odt	0.00	282,707.92	282,707.92
60 $/odt	0.00	1,154,256.21	1,154,256.21
70 $/odt	0.00	1,856,877.85	1,856,877.85
80 $/odt	0.00	2,556,249.86	2,556,249.86
90 $/odt	0.00	3,078,681.31	3,078,681.31
100 $/odt	219.72	3,515,655.37	3,515,875.09
110 $/odt	14,008.00	3,686,358.00	3,700,366.00
120 $/odt	75,105.87	3,754,926.56	3,830,032.43
130 $/odt	210,404.34	3,824,708.18	4,035,112.53
140 $/odt	375,341.52	3,844,052.04	4,219,393.55
150 $/odt	584,108.59	3,879,921.02	4,464,029.60
160 $/odt	846,860.67	3,879,921.02	4,726,781.69
170 $/odt	1,069,073.64	3,879,921.02	4,948,994.66
180 $/odt	1,280,185.26	3,879,921.02	5,160,106.28
190 $/odt	1,382,335.99	3,879,921.02	5,262,257.01
200 $/odt	1,434,283.36	3,879,921.02	5,314,204.38
210 $/odt	1,470,034.66	3,879,921.02	5,349,955.68
220 $/odt	1,478,905.15	3,879,921.02	5,358,826.17
230 $/odt	1,492,180.07	3,879,921.02	5,372,101.09
240 $/odt	1,504,661.03	3,879,921.02	5,384,582.05
250 $/odt	1,505,017.81	3,879,921.02	5,384,938.83

[a] The amount of biomass delivered to Quesnel is divided into $10 increments based on delivered cost.

Fuel at $2/L

Setting the price of fuel parameters to $2/L represented a 60% increase in fuel costs from the base case ($1.25/L). This resulted in a 16% increase in delivered biomass costs and a reduction of 57% in the amount of volume deliverable for $60/ODT, to 37 000 ODT Years 1 to 10. At the $90/ODT threshold, the volume of available biomass drops to only 23% compared to the base case. The cost-availability table for this run is in Appendix 1.6.

Working time scenarios

FPInterface is fairly sensitive to changes in the amount of available working time. If the daily shift is lengthened to 12 h from 10 h in the base case, i.e., a change of 20%, the cost of delivered biomass is reduced by 8% and the amount of available biomass at $60/ODT increases by 34%. At $90/ODT the increase in available biomass is only 11%.

If the length of the working year is lengthened to 200 days (from 180 in the base case, a change of 11%), the cost of delivered biomass is reduced by 5% and the amount of available biomass at $60/ODT increases by 21%.

The cost-availability tables for these runs are in Appendices 1.7 and 1.8.

Slash freshness

The impact of slash freshness on biomass piled at roadside requires further study. The trade-off between allowing piles to dry naturally to increase the calorific value by reducing moisture content and the loss in biomass material from rotting and needle drop varies by ecological zone. When changing the slash to “brown” (3 to 24 months) instead of the base case “fresh” (0 to 3 months) in the model, the cost did not decrease but the amount of available biomass was reduced by 14%. Future studies might show that costs do decrease if more calorific value can be hauled per truck load. The cost-availability table for this run is in Appendix 1.9.

Topping diameter of 10 cm

Decreasing the topping diameter to the regulation specification of 10 cm from 13 cm (a change of 23%) did not change the cost of delivering biomass but reduced its availability at $60/ODT by 16%. The cost-availability table for this run is in Appendix 1.10.

Lodgepole pine utilization

Estimations for the state of mountain pine beetle attack on lodgepole pine are contained in the THLB attribute information. However, it was thought reasonable to further reduce the lodgepole pine harvest by 30%. In the base case, half of this 30% was thought to become available as whole trees for biomass. If all of this 30% had been harvested as sawlogs, then standard harvest residues would be available for 100% of the lodgepole pine volume (instead of 85%) and no stems would be comminuted.

This scenario, called “No stems for biomass”, reduced the average costs of biomass delivery by 25% and increased the amount available by 8% at $60/ODT; however, there was no reduction in costs for biomass at this threshold. This is because the reduction in costs amounted to the elimination of much more expensive purpose-harvested stemwood. None of this wood is available until the $100/ODT cost class. Because no stem wood is available, total available biomass is reduced by 22% to 3.18 m ODT. The cost-availability table for this run is in Appendix 1.11.

If none of the 30% of potential further loss to mountain pine beetle described above becomes available for biomass (called “no biomass recovered from MPB losses”), then cost of biomass is reduced by 26% for the same reasons described above. However, biomass supply at $60/ODT is reduced by 6% and total available biomass is reduced by 37% to 2.58 M ODT. The cost-availability table for this run is in Appendix 1.12.

Issues requiring resolution

During execution of the project it became evident that a number of issues in the model could be streamlined. Many of these are documented in the Methods section.

The first issue was the structure of the Vegetation Resources Inventory data. The sorting of species into columns by leading species, second species, etc., required hours of sorting by FPInnovations staff. After discussion with the MFLNRO staff on March 8, 2011, it was determined that sorted data already exists at the MFLNRO and it would be available for future projects.

The immense size of the dataset proved unwieldy. A time-consuming block aggregation process ensued. The result was effective and allowed for efficient handling in the program. This aggregation process should be codified and, if possible, automated for future projects.

Additionally, many polygons were eliminated that had no merchantable volume, i.e., those that were <0.5 ha in size or had average tree sizes of <0.15 m^3. Removing blocks <0.5 ha in size caused a <1% reduction in volume and removing polygons with <0.15 piece size reduced volume by <3%. Many of these small polygons were created by intersecting the input layers to form the resultant. They may reflect inexact alignment of the input layers. A process to clean or align these layers would speed data handling in future projects.

The MFLNRO’s road dataset contained many unjoined road intersections and required extensive data cleaning. This proved very time consuming. As much as possible, road snapping should be accomplished before future projects are undertaken. Perhaps a protocol for snapping can be established.

The road snapping completed by FPInterface was targeted and did not snap all roads in the dataset. For efficiency, many roads were eliminated from the dataset. It is possible that sub-optimal paths resulted and estimated costs for delivery may have been too high. There is an even greater chance that sub-optimal paths to non-Quesnel mills resulted because road snapping targeted delivery to Quesnel.

The most current version of FPInterface (1.2.0.3) was used for this project but it had little in the way of British Columbia data in its biomass equations. If British Columbia equations were available, these would likely increase the predictive accuracy of the tool. To test this, some of the data were run through BiosMatrix which uses British Columbia equations from 1985. The resulting biomass ratio approximated that generated by FPInterface. Nevertheless, because British Columbia biomass equations have recently become available they should be incorporated into FPInterface for future British Columbia projects.

Several versions of FPInterface were introduced during the execution of the project. These tended to speed up the work and make the model more user-friendly. However the most recent version disabled the multiple delivery point function that allowed blocks to be delivered to the nearest mill. A work-around was found by doing multiple runs; however, this functionality should be restored in future versions of the program. Continued enhancement of the program is encouraged.

6. Conclusions

In 2011 FPInnovations used FPInterface to develop and demonstrate a method for estimating the availability of forest-origin biomass in British Columbia Timber Supply Areas: the Quesnel TSA was the test case. 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 Resources. Quesnel was designated as the delivery point in the primary analysis, and additional analyses were undertaken for delivery points at Williams Lake, Prince George, and Anahim Lake. Several analyses were undertaken to test the sensitivity of the biomass estimates to changes in fuel costs, annual operating hours, topping diameter of sawlogs, and slash freshness, and and to test the sensitivity of excluding recovery of dead mountain pine beetle-attacked stands. All planned blocks were assumed to be clearcut harvested, processed at roadside, and accessible to comminution operations.

The total biomass delivered to the city of Quesnel over the Years 1 to 10 was projected to be 4.077 million ODT, and 850 000 ODT (or approximately 85 000 ODT/year) was available, at $60/ODT. The amount of biomass available in Years 11 to 20 was about 30 000 ODT/year, at $60/ODT. If the acceptable price of delivered biomass rises to $90/ODT the amount of available biomass would nearly triple for both time periods.

Little biomass from the Quesnel TSA was available to mills or centres outside of Quesnel for a lower cost than for delivering to Quesnel because the road system is optimized to Quesnel.

Some areas for improvement were identified, i.e., to enhance the established method of biomass estimation, including: establishing protocols for better data acquisition, alignment, cleaning, and aggregation; acquiring and inputing British Columbia biomass equations into FPInterface; and further enhancing and developing FPInterface in order to speed up the model's run time in future projects.

7. References

Lambert, M-C., Ung, C-H., & Raulier, R. (2005). Canadian national tree aboveground biomass equations. *Canadian Journal of Forest Research* 35:1996–2008.

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Standish, J. T., Manning, G. H., & Demaerschalk, J. P. (1985). *Development of biomass equations for British Columbia tree species* (Information Report BC-X-264). Victoria, British Columbia: Canadian Forestry Service, Pacific Forestry Centre.

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* 35:1123-1132.

8. Appendix

Appendix 1

Output maps and cost-availability tables from the 10-year base case and other scenarios

1.1 10-Year Base Case

1.2 Williams Lake

1.3 Prince George

1.4 Anahim Lake

1.5 20-year Horizon

1.6 Fuel at $2/L

1.7 12-hour Shifts

1.8 200-day Year

1.9 Brown Slash

1.10 Topping at10 cm

1.11 No Stems for Biomass

1.12 No Biomass Recovered from mountain pine beetle Losses

FPInterface™

Summary report
Biomass
[ques 23mar2011]

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	4,077,343.7 odt
Recovery rate	20.8 odt/ha
Biomass/Harvest	0.1354
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	30 : 1
Available energy	15,630,330 MWh
Fuel consumption	15 L/odt

Cost

Harvesting related costs	22.52 $/odt
Biomass recovery costs	31.80 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	43.11 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**97.43 $/ odt**

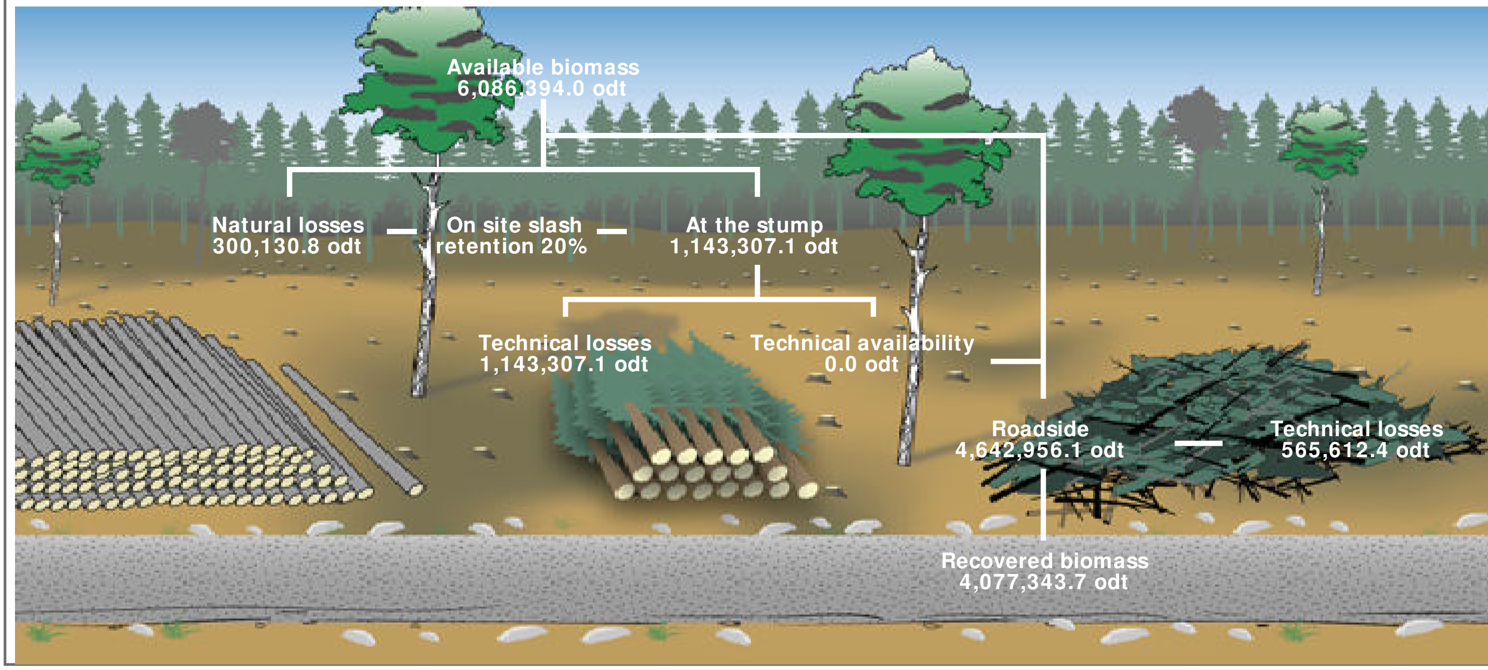
Revenue

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

Net

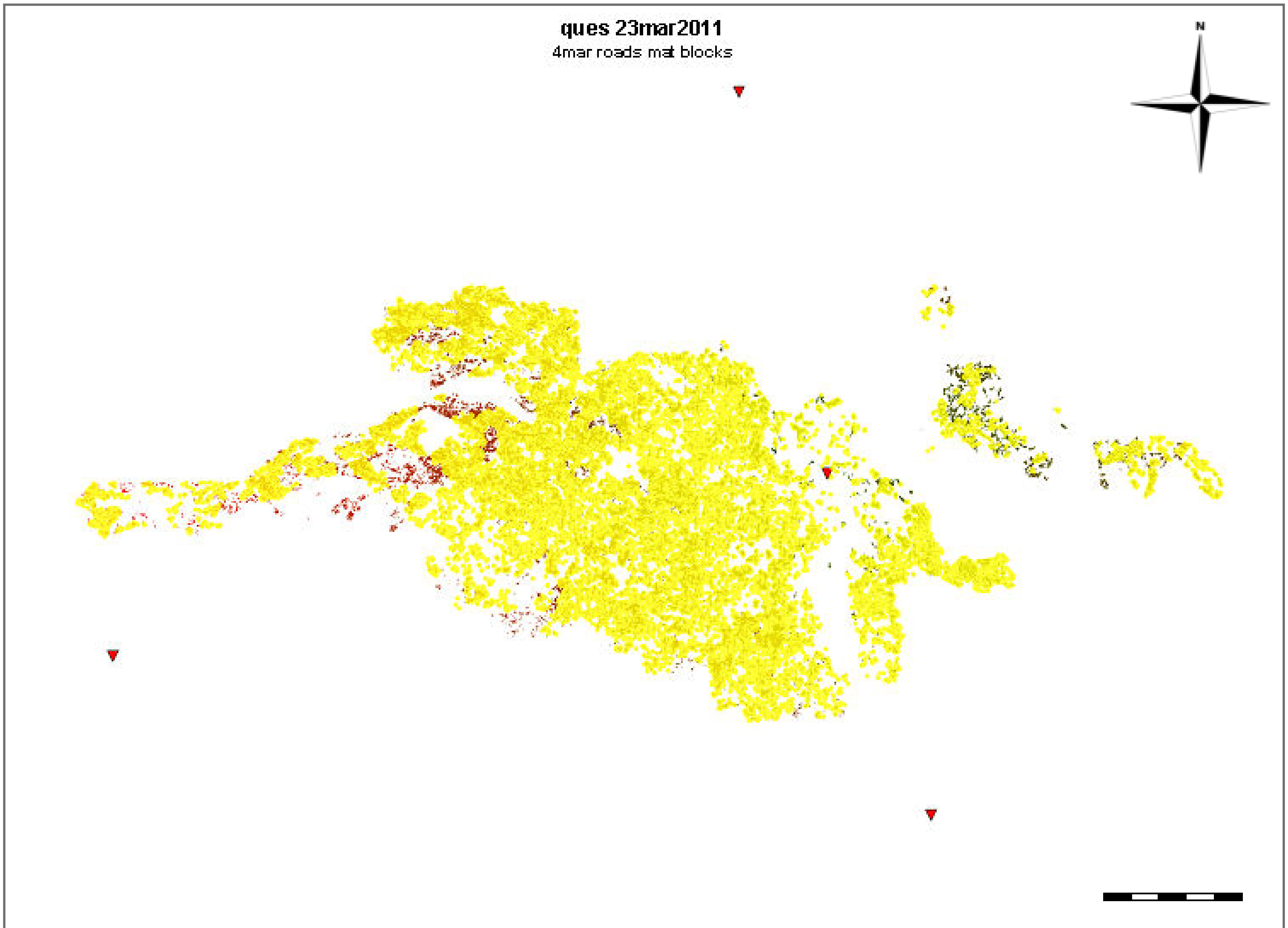
Profit	-97.43 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-- (slash)	1,401,439.9	0.1062	7.15
Lodgepole Pine-biomass	1,242,894.8	0.3829	6.34
X Spruce-- (slash)	781,285.1	0.1193	3.99
Lodgepole Pine-biomass (slash)	258,094.5	0.0913	1.32
Douglas Fir-- (slash)	162,048.1	0.0821	0.83
Trembling Aspen-- (slash)	108,184.1	0.1407	0.55
White Spruce-- (slash)	53,430.6	0.1069	0.27
Amabilis Fir-- (slash)	35,281.3	0.0923	0.18
Abies lasiocarpa-- (slash)	14,457.6	0.101	0.07
Balsam Poplar-- (slash)	7,104.1	0.0941	0.04
Western Redcedar-- (slash)	6,029.0	0.1009	0.03
White birch-- (slash)	2,997.4	0.0081	0.02
Black Spruce-- (slash)	2,741.5	0.135	0.01
Western Hemlock-- (slash)	872.2	0.0861	0
Cottonwood-- (slash)	252.3	0.1525	0
Tamarack-- (slash)	231.0	0.1704	0
	4,077,343.7		**20.81**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	4,077,343.68	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	4,077,343.68	195,976.21	3,412
• Slash freshness			
Fresh	4,077,343.68	195,976.21	3,412
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	1,164.15	1,164.15
50 $/odt	0.00	226,613.22	226,613.22
60 $/odt	0.00	857,513.69	857,513.69
70 $/odt	0.00	1,375,861.93	1,375,861.93
80 $/odt	0.00	1,950,746.61	1,950,746.61
90 $/odt	0.00	2,361,040.68	2,361,040.68
100 $/odt	165.43	2,645,988.13	2,646,153.55
110 $/odt	12,537.77	2,724,434.98	2,736,972.75
120 $/odt	61,323.00	2,763,206.80	2,824,529.80
130 $/odt	186,960.66	2,800,700.00	2,987,660.66
140 $/odt	341,195.19	2,809,839.67	3,151,034.86
150 $/odt	537,662.57	2,834,448.91	3,372,111.48
160 $/odt	788,348.01	2,834,448.91	3,622,796.91
170 $/odt	986,489.40	2,834,448.91	3,820,938.30
180 $/odt	1,107,662.18	2,834,448.91	3,942,111.09
190 $/odt	1,169,603.05	2,834,448.91	4,004,051.95
200 $/odt	1,196,596.85	2,834,448.91	4,031,045.76
210 $/odt	1,220,419.66	2,834,448.91	4,054,868.57
220 $/odt	1,225,345.86	2,834,448.91	4,059,794.77
230 $/odt	1,232,800.12	2,834,448.91	4,067,249.02
240 $/odt	1,242,459.96	2,834,448.91	4,076,908.86
250 $/odt	1,242,598.90	2,834,448.91	4,077,047.81

260 $/odt	1,242,747.63	2,834,448.91	4,077,196.53
270 $/odt	1,242,865.25	2,834,448.91	4,077,314.16
280 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
290 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
300 $/odt	1,242,894.77	2,834,448.91	4,077,343.68
Maximum cost	**291.38 $/ odt**	**148.76 $/ odt**	

FPInterface™

Summary report
Forest supply
[ques 23mar2011]

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

Cut blocks

Area	195,976 ha
Number of cut blocks	3412
Average skidding dist.	250 m
Cut type	
Total	195,976 ha
Harvesting system	
Full-tree	195,976 ha

Terrain conditions

CPPA class	Ground strength (%)	Roughness (%)	Slope (%)
1	100	100	-
2	-	-	-
3	-	-	100
4	-	-	-
5	-	-	-

Costs - Selected items

Harvesting cost	28.68 $/m³
Machine movement cost	N/A
Road network - Construction costs	0.00 $/m³
Road network - Maintenance costs	N/A
Transport costs	0.00 $/m³
Transfer yard cost	0.00 $/m³
Stumpage fees	0.00 $/m³
Indirect costs	0.00 $/m³
Stand establishment costs	N/A
Total cost	**28.68 $/ m³**

Revenue

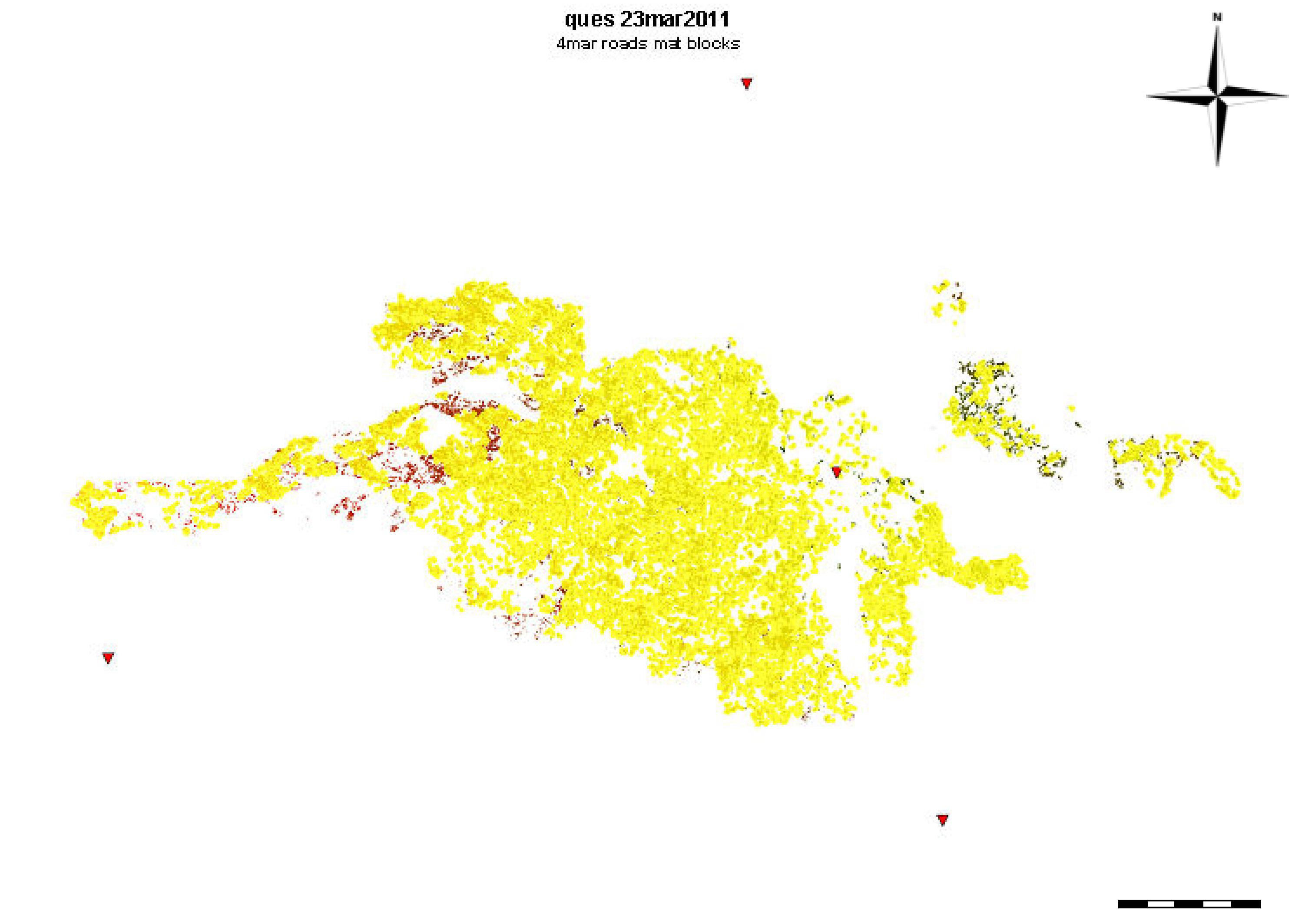
Value	0.00 $/m³
Reimbursements (silv.)	N/A

Net

Profit	-28.68 $/m³

Products

Name	Format	m³	m³ / ha	m³ / stem	% / total
Lodgepole Pine--	Stems	13,192,956	67.3	0.203	49
X Spruce--	Stems	6,547,295	33.4	0.364	24
Douglas Fir--	Stems	1,973,824	10.1	0.366	7
Trembling Aspen--	Stems	769,146	3.9	0.202	3
White Spruce--	Stems	499,982	2.6	0.489	2
Amabilis Fir--	Stems	382,415	2.0	0.344	1
White birch--	Stems	367,830	1.9	64.205	1
Abies lasiocarpa--	Stems	143,093	0.7	0.267	1
Balsam Poplar--	Stems	75,488	0.4	0.377	0
Western Redcedar--	Stems	59,759	0.3	0.267	0
Black Spruce--	Stems	20,306	0.1	0.294	0
Western Hemlock--	Stems	10,133	0.1	0.437	0
Cottonwood--	Stems	1,654	0.0	0.177	0
Tamarack--	Stems	1,356	0.0	0.221	0
		24,045,237	**122.7**	**0.252**	**89**

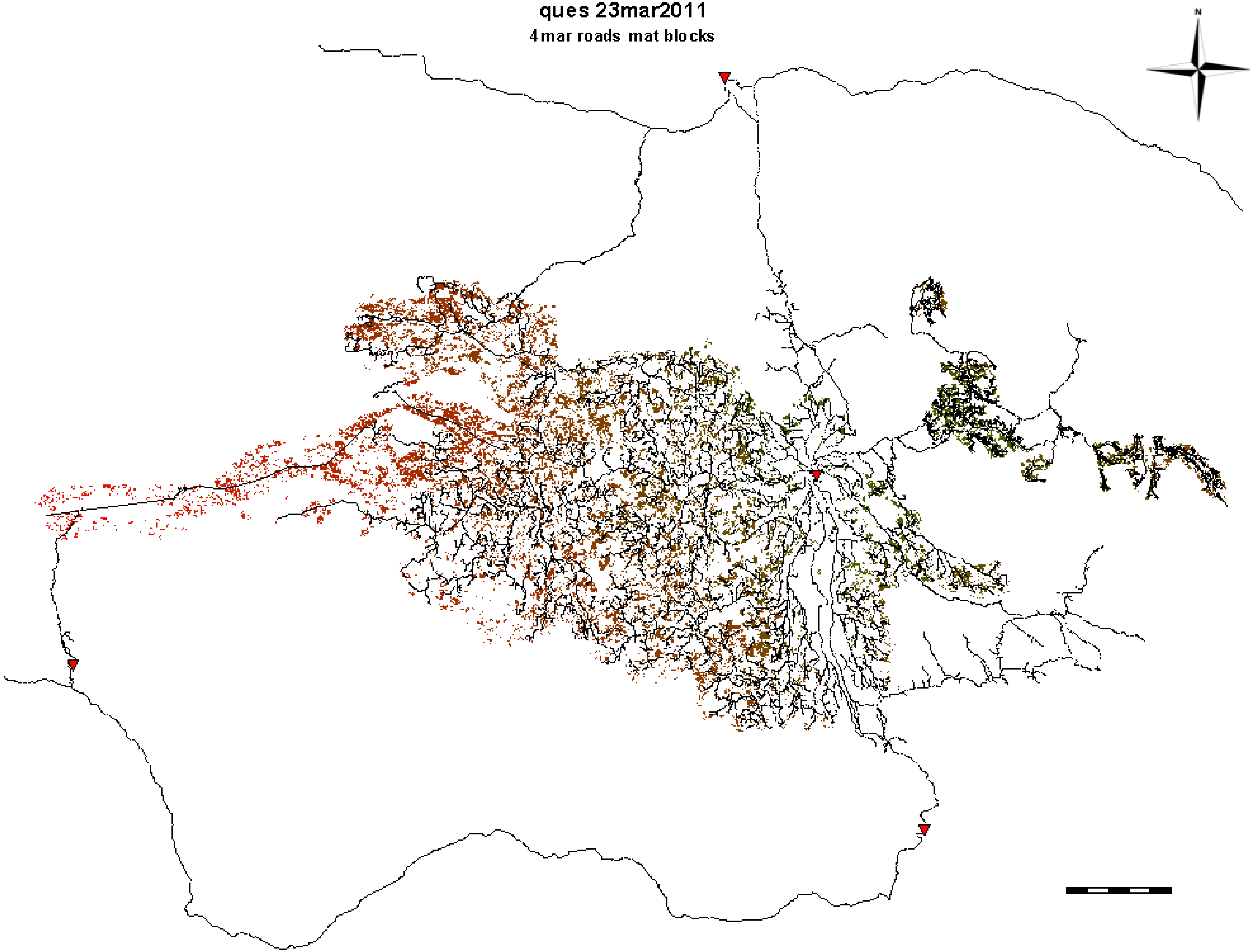


3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

ques 23mar2011

4mar roads mat blocks



ques 23mar2011

4mar roads mat blocks

FPInterface™

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	4,077,343.7 odt
Recovery rate	20.8 odt/ha
Biomass/Harvest	0.1354
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	19 : 1
Available energy	15,630,330 MWh
Fuel consumption	23 L/odt

Cost

Harvesting related costs	22.52 $/odt
Biomass recovery costs	31.80 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	72.36 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**126.68 $/ odt**

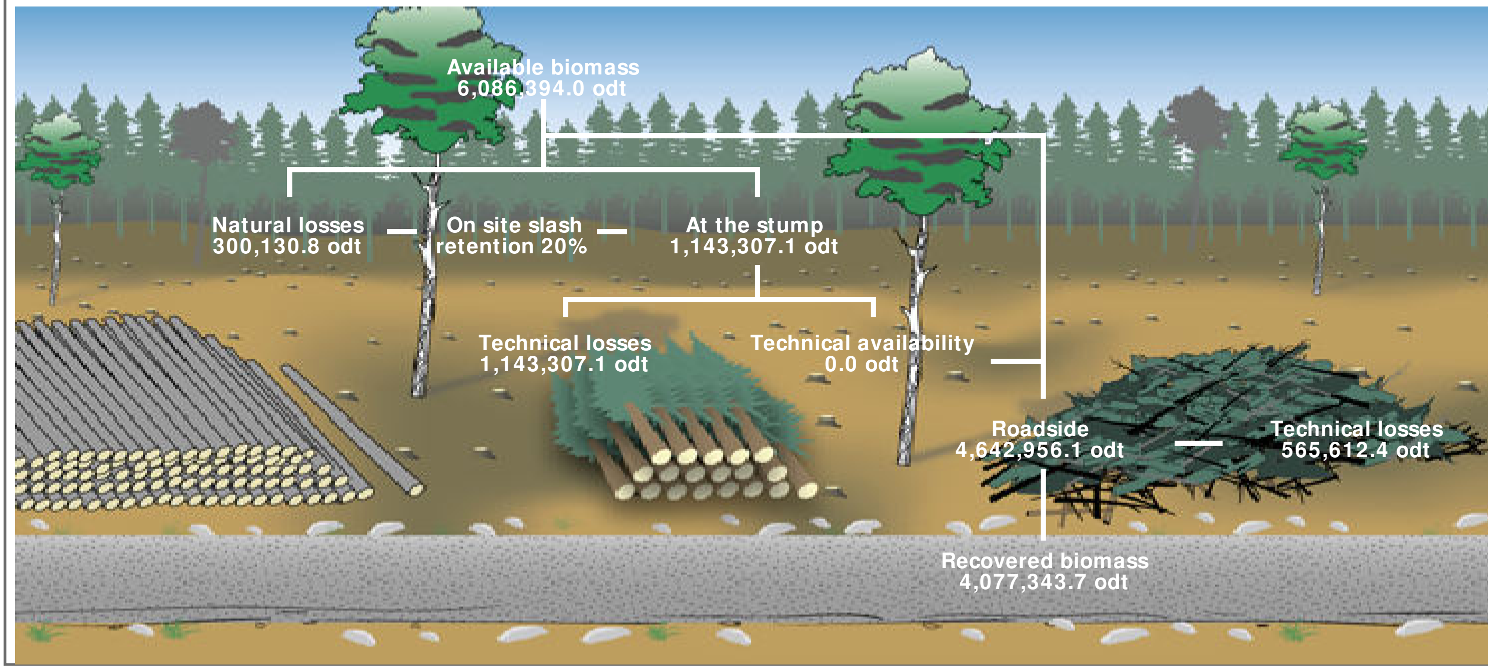
Revenue

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

Net

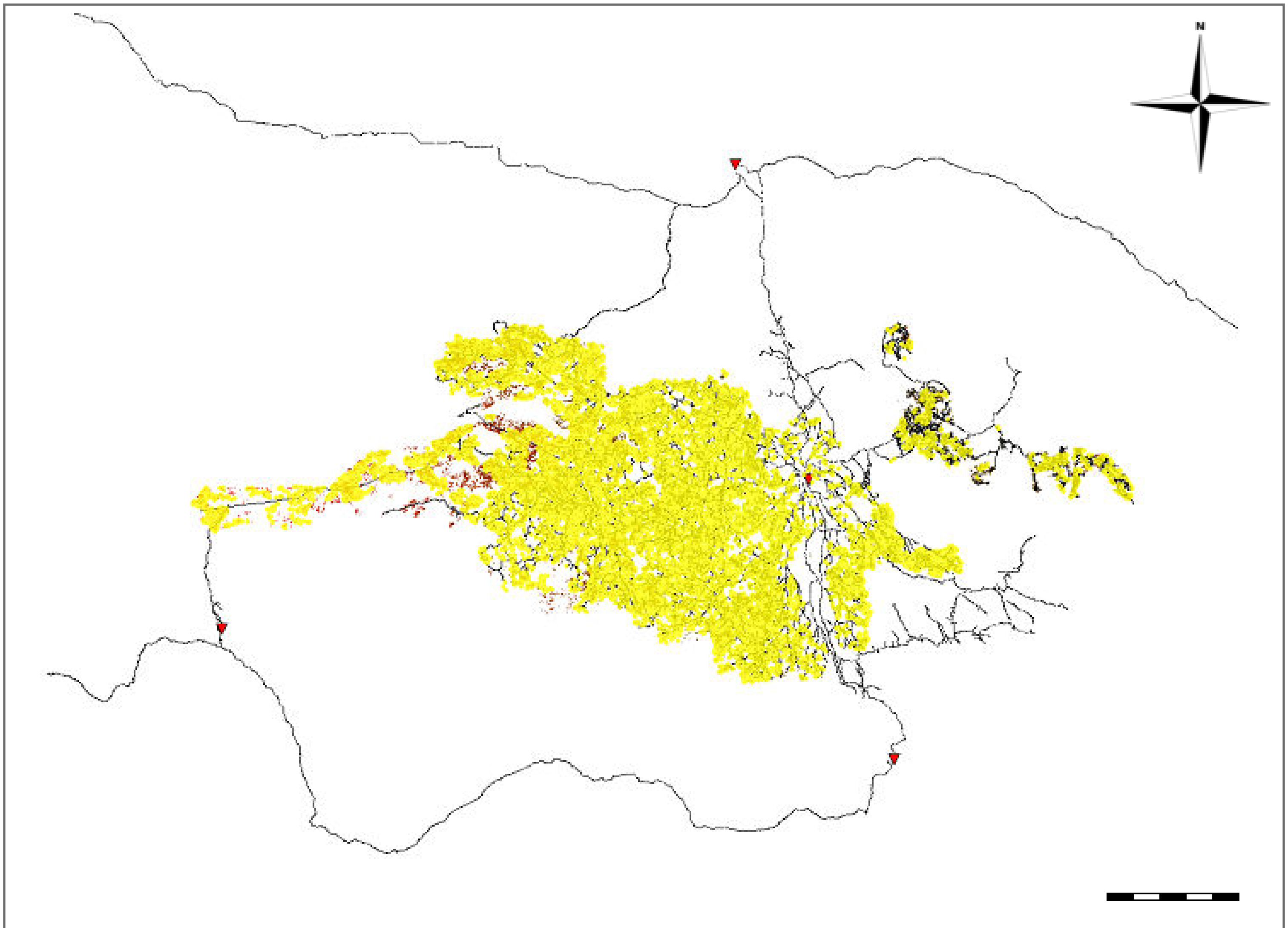
Profit	-126.68 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-- (slash)	1,401,439.9	0.1062	7.15
Lodgepole Pine-biomass	1,242,894.8	0.3829	6.34
X Spruce-- (slash)	781,285.1	0.1193	3.99
Lodgepole Pine-biomass (slash)	258,094.5	0.0913	1.32
Douglas Fir-- (slash)	162,048.1	0.0821	0.83
Trembling Aspen-- (slash)	108,184.1	0.1407	0.55
White Spruce-- (slash)	53,430.6	0.1069	0.27
Amabilis Fir-- (slash)	35,281.3	0.0923	0.18
Abies lasiocarpa-- (slash)	14,457.6	0.101	0.07
Balsam Poplar-- (slash)	7,104.1	0.0941	0.04
Western Redcedar-- (slash)	6,029.0	0.1009	0.03
White birch-- (slash)	2,997.4	0.0081	0.02
Black Spruce-- (slash)	2,741.5	0.135	0.01
Western Hemlock-- (slash)	872.2	0.0861	0
Cottonwood-- (slash)	252.3	0.1525	0
Tamarack-- (slash)	231.0	0.1704	0
	4,077,343.7		**20.81**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	4,077,343.68	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	4,077,343.68	195,976.21	3,412
• Slash freshness			
Fresh	4,077,343.68	195,976.21	3,412
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	0.00	0.00
50 $/odt	0.00	0.00	0.00
60 $/odt	0.00	11,197.37	11,197.37
70 $/odt	0.00	57,157.36	57,157.36
80 $/odt	0.00	368,513.31	368,513.31
90 $/odt	0.00	906,370.85	906,370.85
100 $/odt	0.00	1,406,516.19	1,406,516.19
110 $/odt	0.00	1,992,723.81	1,992,723.81
120 $/odt	372.46	2,396,115.11	2,396,487.57
130 $/odt	4,616.93	2,660,527.07	2,665,143.99
140 $/odt	20,437.68	2,724,434.98	2,744,872.66
150 $/odt	64,760.11	2,796,753.43	2,861,513.54
160 $/odt	176,245.60	2,834,448.91	3,010,694.51
170 $/odt	303,008.54	2,834,448.91	3,137,457.45
180 $/odt	484,463.48	2,834,448.91	3,318,912.39
190 $/odt	748,257.09	2,834,448.91	3,582,706.00
200 $/odt	956,381.66	2,834,448.91	3,790,830.57
210 $/odt	1,087,255.53	2,834,448.91	3,921,704.43
220 $/odt	1,163,934.72	2,834,448.91	3,998,383.63
230 $/odt	1,193,740.85	2,834,448.91	4,028,189.76
240 $/odt	1,227,261.11	2,834,448.91	4,061,710.02
250 $/odt	1,240,899.17	2,834,448.91	4,075,348.08

260 $/odt	1,242,516.34	2,834,448.91	4,076,965.25
270 $/odt	1,242,569.80	2,834,448.91	4,077,018.71
280 $/odt	1,242,587.74	2,834,448.91	4,077,036.65
290 $/odt	1,242,756.09	2,834,448.91	4,077,205.00
300 $/odt	1,242,843.15	2,834,448.91	4,077,292.06
310 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
320 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
330 $/odt	1,242,894.77	2,834,448.91	4,077,343.68
Maximum cost	**323.18 $/ odt**	**156.87 $/ odt**	

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	4,077,343.7 odt
Recovery rate	20.8 odt/ha
Biomass/Harvest	0.1354
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	18 : 1
Available energy	15,630,330 MWh
Fuel consumption	24 L/odt

Cost

Harvesting related costs	22.52 $/odt
Biomass recovery costs	31.80 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	75.28 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**129.60 $/ odt**

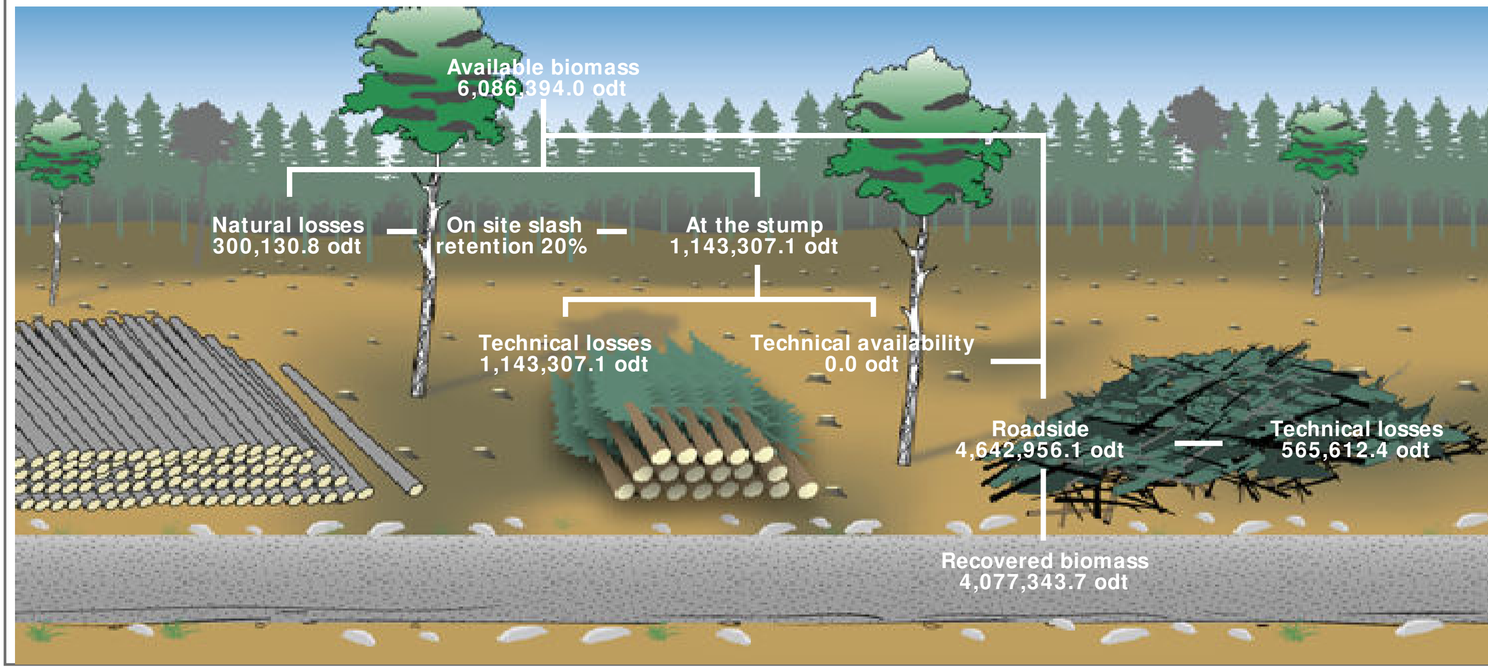
Revenue

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

Net

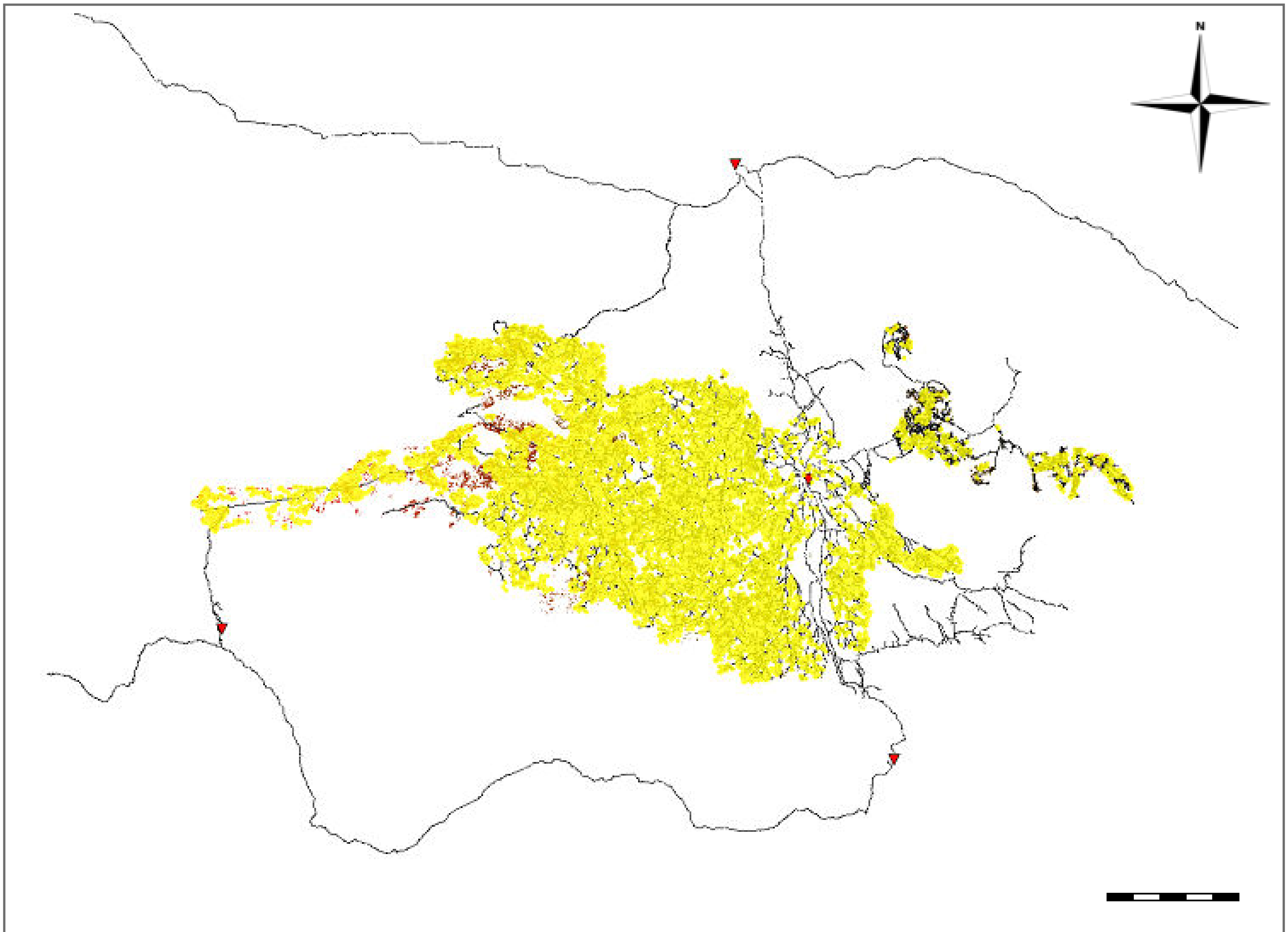
Profit	-129.60 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-- (slash)	1,401,439.9	0.1062	7.15
Lodgepole Pine-biomass	1,242,894.8	0.3829	6.34
X Spruce-- (slash)	781,285.1	0.1193	3.99
Lodgepole Pine-biomass (slash)	258,094.5	0.0913	1.32
Douglas Fir-- (slash)	162,048.1	0.0821	0.83
Trembling Aspen-- (slash)	108,184.1	0.1407	0.55
White Spruce-- (slash)	53,430.6	0.1069	0.27
Amabilis Fir-- (slash)	35,281.3	0.0923	0.18
Abies lasiocarpa-- (slash)	14,457.6	0.101	0.07
Balsam Poplar-- (slash)	7,104.1	0.0941	0.04
Western Redcedar-- (slash)	6,029.0	0.1009	0.03
White birch-- (slash)	2,997.4	0.0081	0.02
Black Spruce-- (slash)	2,741.5	0.135	0.01
Western Hemlock-- (slash)	872.2	0.0861	0
Cottonwood-- (slash)	252.3	0.1525	0
Tamarack-- (slash)	231.0	0.1704	0
	4,077,343.7		**20.81**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	4,077,343.68	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	4,077,343.68	195,976.21	3,412
• Slash freshness			
Fresh	4,077,343.68	195,976.21	3,412
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	0.00	0.00
50 $/odt	0.00	0.00	0.00
60 $/odt	0.00	0.00	0.00
70 $/odt	0.00	6,022.31	6,022.31
80 $/odt	0.00	156,374.96	156,374.96
90 $/odt	0.00	712,306.62	712,306.62
100 $/odt	0.00	1,270,674.00	1,270,674.00
110 $/odt	0.00	1,892,074.16	1,892,074.16
120 $/odt	0.00	2,336,479.54	2,336,479.54
130 $/odt	0.00	2,632,425.40	2,632,425.40
140 $/odt	2,833.57	2,712,967.44	2,715,801.01
150 $/odt	34,394.56	2,763,206.80	2,797,601.36
160 $/odt	152,752.39	2,798,966.31	2,951,718.70
170 $/odt	283,299.36	2,806,470.81	3,089,770.18
180 $/odt	442,301.10	2,834,185.43	3,276,486.54
190 $/odt	709,413.92	2,834,448.91	3,543,862.83
200 $/odt	919,801.74	2,834,448.91	3,754,250.65
210 $/odt	1,055,559.60	2,834,448.91	3,890,008.51
220 $/odt	1,149,161.70	2,834,448.91	3,983,610.60
230 $/odt	1,186,091.17	2,834,448.91	4,020,540.07
240 $/odt	1,218,620.92	2,834,448.91	4,053,069.83
250 $/odt	1,222,952.27	2,834,448.91	4,057,401.18

260 $/odt	1,227,560.92	2,834,448.91	4,062,009.82
270 $/odt	1,241,917.24	2,834,448.91	4,076,366.15
280 $/odt	1,242,533.16	2,834,448.91	4,076,982.07
290 $/odt	1,242,598.90	2,834,448.91	4,077,047.81
300 $/odt	1,242,833.07	2,834,448.91	4,077,281.98
310 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
320 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
330 $/odt	1,242,894.77	2,834,448.91	4,077,343.68
Maximum cost	**322.14 $/ odt**	**180.18 $/ odt**	

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	4,077,343.7 odt
Recovery rate	20.8 odt/ha
Biomass/Harvest	0.1354
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	11 : 1
Available energy	15,630,330 MWh
Fuel consumption	39 L/odt

Cost

Harvesting related costs	22.52 $/odt
Biomass recovery costs	31.80 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	134.39 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**188.71 $/ odt**

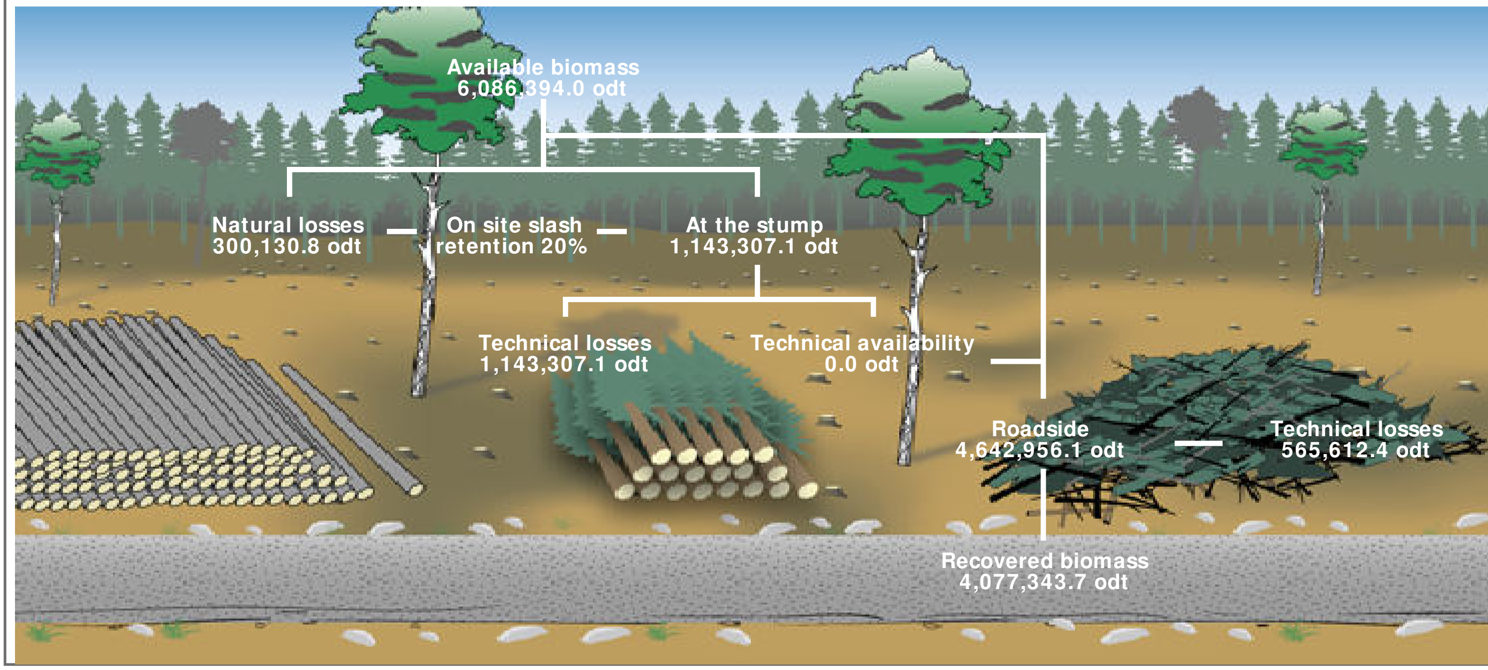
Revenue

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

Net

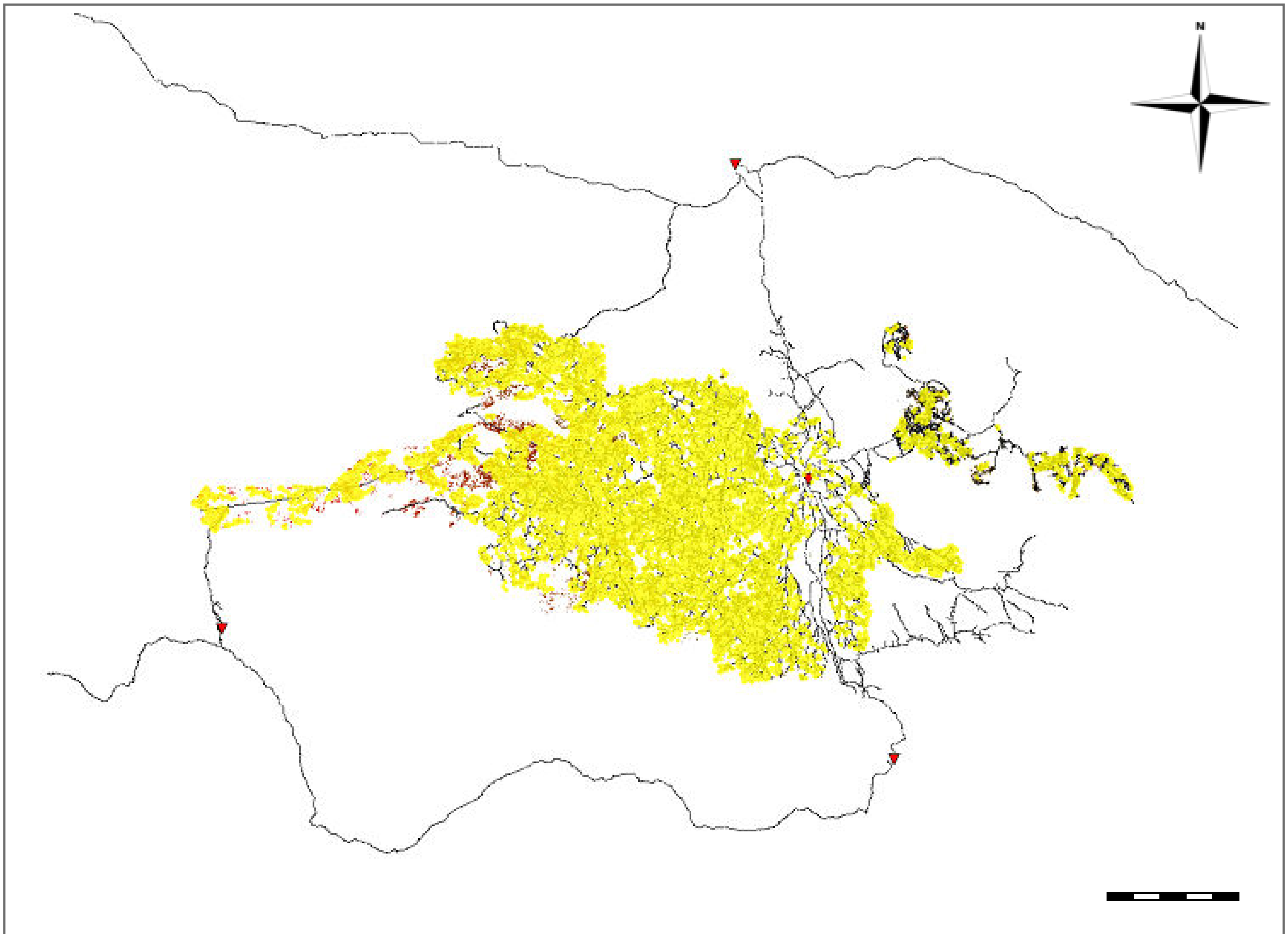
Profit	-188.71 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-- (slash)	1,401,439.9	0.1062	7.15
Lodgepole Pine-biomass	1,242,894.8	0.3829	6.34
X Spruce-- (slash)	781,285.1	0.1193	3.99
Lodgepole Pine-biomass (slash)	258,094.5	0.0913	1.32
Douglas Fir-- (slash)	162,048.1	0.0821	0.83
Trembling Aspen-- (slash)	108,184.1	0.1407	0.55
White Spruce-- (slash)	53,430.6	0.1069	0.27
Amabilis Fir-- (slash)	35,281.3	0.0923	0.18
Abies lasiocarpa-- (slash)	14,457.6	0.101	0.07
Balsam Poplar-- (slash)	7,104.1	0.0941	0.04
Western Redcedar-- (slash)	6,029.0	0.1009	0.03
White birch-- (slash)	2,997.4	0.0081	0.02
Black Spruce-- (slash)	2,741.5	0.135	0.01
Western Hemlock-- (slash)	872.2	0.0861	0
Cottonwood-- (slash)	252.3	0.1525	0
Tamarack-- (slash)	231.0	0.1704	0
	4,077,343.7		**20.81**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	4,077,343.68	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	4,077,343.68	195,976.21	3,412
• Slash freshness			
Fresh	4,077,343.68	195,976.21	3,412
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	0.00	0.00
50 $/odt	0.00	0.00	0.00
60 $/odt	0.00	0.00	0.00
70 $/odt	0.00	8,682.87	8,682.87
80 $/odt	0.00	35,482.60	35,482.60
90 $/odt	0.00	71,242.11	71,242.11
100 $/odt	0.00	121,481.47	121,481.47
110 $/odt	0.00	193,269.90	193,269.90
120 $/odt	0.00	224,604.55	224,604.55
130 $/odt	0.00	281,068.38	281,068.38
140 $/odt	511.74	445,662.57	446,174.31
150 $/odt	3,512.46	663,776.44	667,288.90
160 $/odt	17,993.69	1,098,618.11	1,116,611.80
170 $/odt	38,634.96	1,648,029.02	1,686,663.99
180 $/odt	52,817.88	2,161,571.16	2,214,389.04
190 $/odt	92,393.24	2,457,568.52	2,549,961.76
200 $/odt	107,236.65	2,771,235.97	2,878,472.63
210 $/odt	133,674.32	2,834,448.91	2,968,123.22
220 $/odt	183,179.80	2,834,448.91	3,017,628.70
230 $/odt	267,974.23	2,834,448.91	3,102,423.13
240 $/odt	386,134.32	2,834,448.91	3,220,583.22
250 $/odt	552,188.30	2,834,448.91	3,386,637.20

260 $/odt	720,412.76	2,834,448.91	3,554,861.67
270 $/odt	930,721.40	2,834,448.91	3,765,170.31
280 $/odt	1,100,004.63	2,834,448.91	3,934,453.54
290 $/odt	1,206,772.32	2,834,448.91	4,041,221.22
300 $/odt	1,238,328.72	2,834,448.91	4,072,777.63
310 $/odt	1,242,193.10	2,834,448.91	4,076,642.01
320 $/odt	1,242,552.60	2,834,448.91	4,077,001.50
330 $/odt	1,242,633.58	2,834,448.91	4,077,082.48
340 $/odt	1,242,649.95	2,834,448.91	4,077,098.85
350 $/odt	1,242,820.37	2,834,448.91	4,077,269.28
360 $/odt	1,242,857.14	2,834,448.91	4,077,306.05
370 $/odt	1,242,865.70	2,834,448.91	4,077,314.61
380 $/odt	1,242,867.41	2,834,448.91	4,077,316.32
390 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
400 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
410 $/odt	1,242,894.77	2,834,448.91	4,077,343.68
Maximum cost	**409.77 $/ odt**	**207.97 $/ odt**	

FPInterface™

Summary report

Biomass

[ques 21mar2011 180d]

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

Statistics - Selected Items

Area	251,600 ha
Number of cut blocks	5077
Recovered biomass	5,385,291.8 odt
Recovery rate	21.4 odt/ha
Biomass/Harvest	0.1339
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	29 : 1
Available energy	20,619,291 MWh
Fuel consumption	15 L/odt

Cost

Harvesting related costs	20.71 $/odt
Biomass recovery costs	31.80 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	44.76 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**97.27 $/ odt**

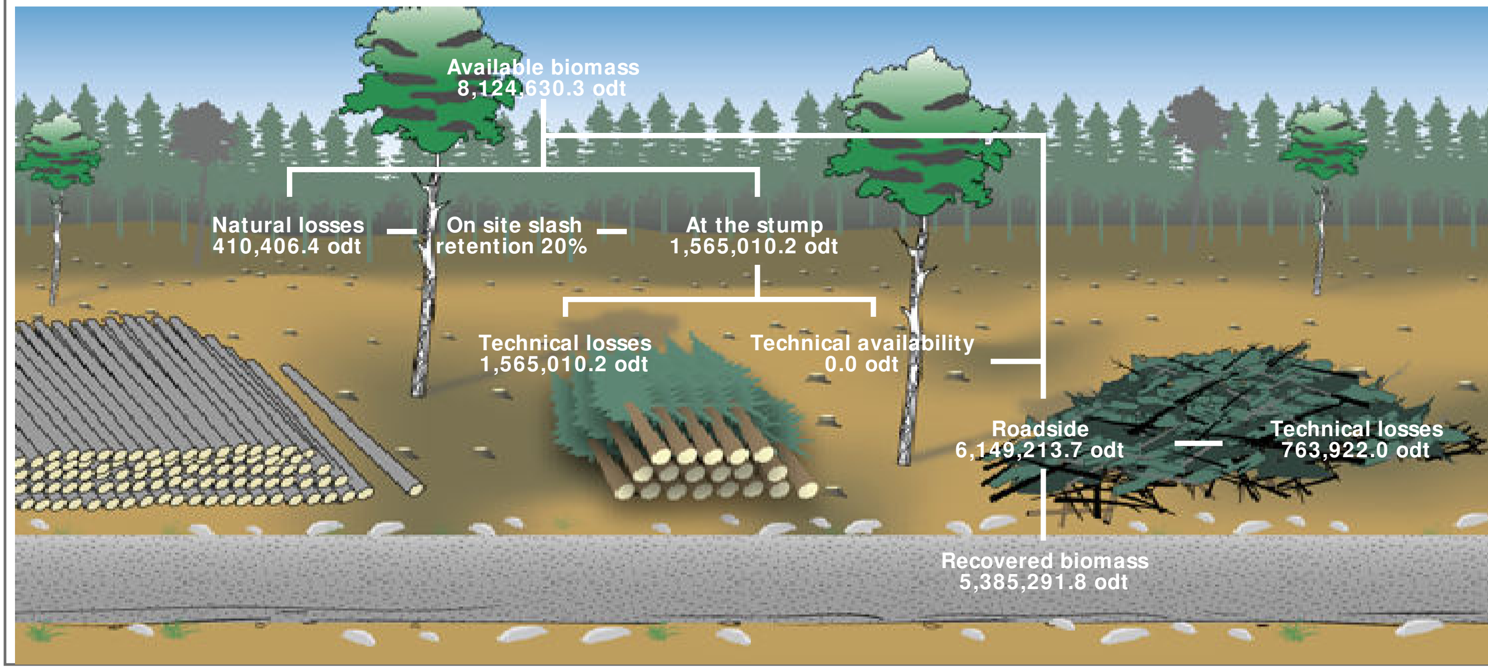
Revenue

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

Net

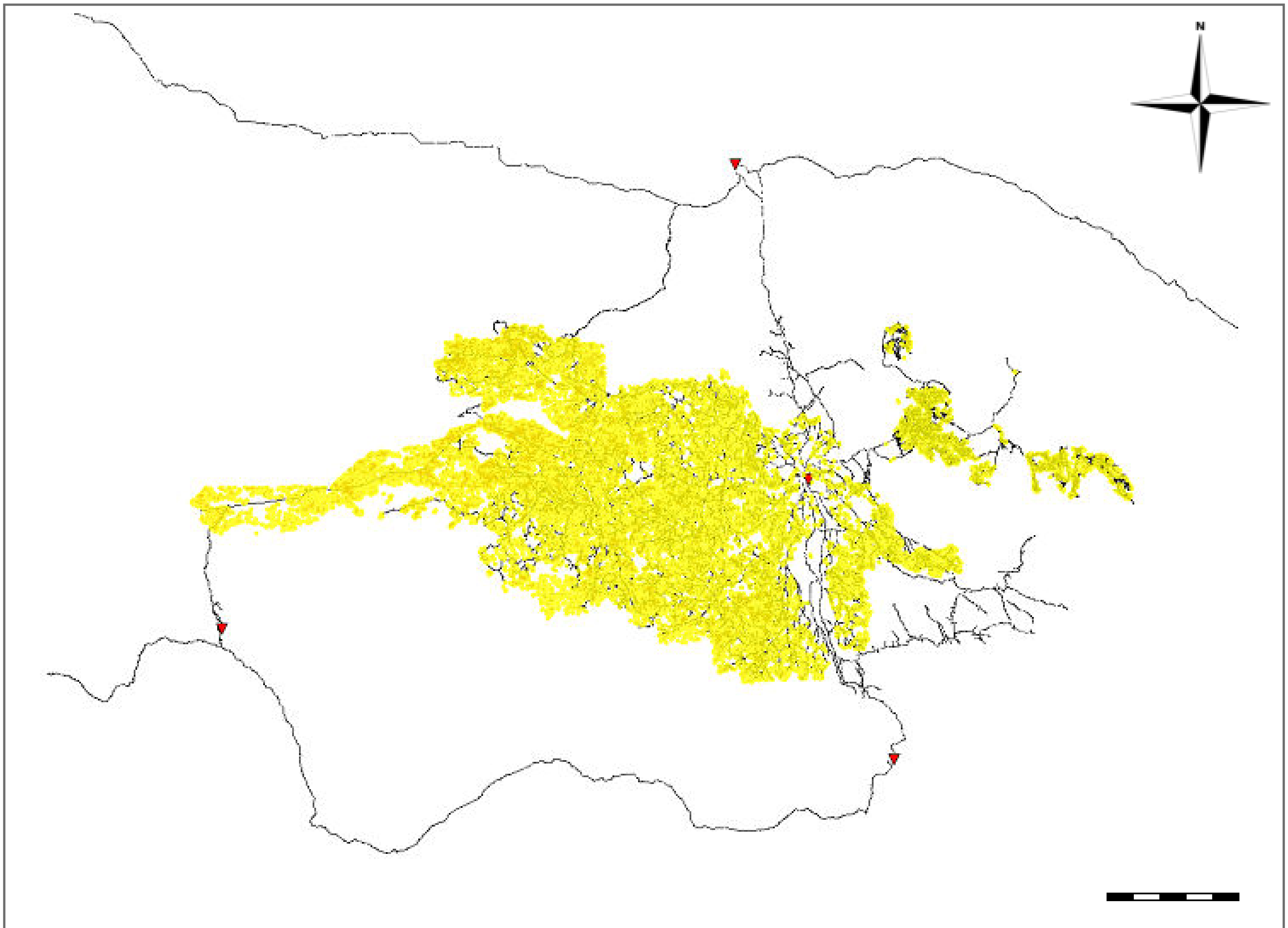
Profit	-97.27 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-- (slash)	1,703,559.5	0.1067	6.77
Lodgepole Pine-biomass	1,505,370.7	0.3829	5.98
X Spruce-- (slash)	1,265,679.1	0.1194	5.03
Lodgepole Pine-biomass (slash)	313,631.9	0.0917	1.25
Douglas Fir-- (slash)	204,878.8	0.0835	0.81
Trembling Aspen-- (slash)	148,053.8	0.1459	0.59
Amabilis Fir-- (slash)	120,509.3	0.0967	0.48
White Spruce-- (slash)	80,527.6	0.1117	0.32
Abies lasiocarpa-- (slash)	16,860.4	0.1023	0.07
Balsam Poplar-- (slash)	9,641.0	0.0922	0.04
Western Redcedar-- (slash)	7,845.4	0.1076	0.03
Black Spruce-- (slash)	3,378.0	0.1374	0.01
White birch-- (slash)	2,997.4	0.0062	0.01
Western Hemlock-- (slash)	1,728.0	0.1157	0.01
Tamarack-- (slash)	319.4	0.1704	0
Cottonwood-- (slash)	311.5	0.1468	0
	5,385,291.8		**21.40**



5077 selected site(s) / 5077

Area covered: 251,600 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	5,385,291.76	251,599.74	5,077
• Recovery season			
Summer	0.00	0.00	0
Winter	5,385,291.76	251,599.74	5,077
• Slash freshness			
Fresh	5,385,291.76	251,599.74	5,077
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	2,061.80	2,061.80
50 $/odt	0.00	282,707.92	282,707.92
60 $/odt	0.00	1,154,256.21	1,154,256.21
70 $/odt	0.00	1,856,877.85	1,856,877.85
80 $/odt	0.00	2,556,249.86	2,556,249.86
90 $/odt	0.00	3,078,681.31	3,078,681.31
100 $/odt	219.72	3,515,655.37	3,515,875.09
110 $/odt	14,008.00	3,686,358.00	3,700,366.00
120 $/odt	75,105.87	3,754,926.56	3,830,032.43
130 $/odt	210,404.34	3,824,708.18	4,035,112.53
140 $/odt	375,341.52	3,844,052.04	4,219,393.55
150 $/odt	584,108.59	3,879,921.02	4,464,029.60
160 $/odt	846,860.67	3,879,921.02	4,726,781.69
170 $/odt	1,069,073.64	3,879,921.02	4,948,994.66
180 $/odt	1,280,185.26	3,879,921.02	5,160,106.28
190 $/odt	1,382,335.99	3,879,921.02	5,262,257.01
200 $/odt	1,434,283.36	3,879,921.02	5,314,204.38
210 $/odt	1,470,034.66	3,879,921.02	5,349,955.68
220 $/odt	1,478,905.15	3,879,921.02	5,358,826.17
230 $/odt	1,492,180.07	3,879,921.02	5,372,101.09
240 $/odt	1,504,661.03	3,879,921.02	5,384,582.05
250 $/odt	1,505,017.81	3,879,921.02	5,384,938.83

260 $/odt	1,505,167.76	3,879,921.02	5,385,088.78
270 $/odt	1,505,285.39	3,879,921.02	5,385,206.40
280 $/odt	1,505,369.19	3,879,921.02	5,385,290.21
290 $/odt	1,505,369.28	3,879,921.02	5,385,290.30
300 $/odt	1,505,370.39	3,879,921.02	5,385,291.41
310 $/odt	1,505,370.39	3,879,921.02	5,385,291.41
320 $/odt	1,505,370.39	3,879,921.02	5,385,291.41
330 $/odt	1,505,370.39	3,879,921.02	5,385,291.41
340 $/odt	1,505,370.39	3,879,921.02	5,385,291.41
350 $/odt	1,505,370.75	3,879,921.02	5,385,291.76
Maximum cost	**347.34 $/ odt**	**148.76 $/ odt**	

FPInterface™

Summary report

Biomass

[ques 23mar2011 fuel200]

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	4,077,343.7 odt
Recovery rate	20.8 odt/ha
Biomass/Harvest	0.1354
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	30 : 1
Available energy	15,630,330 MWh
Fuel consumption	15 L/odt

Cost

Harvesting related costs	24.62 $/odt
Biomass recovery costs	36.70 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	49.81 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**111.13 $/ odt**

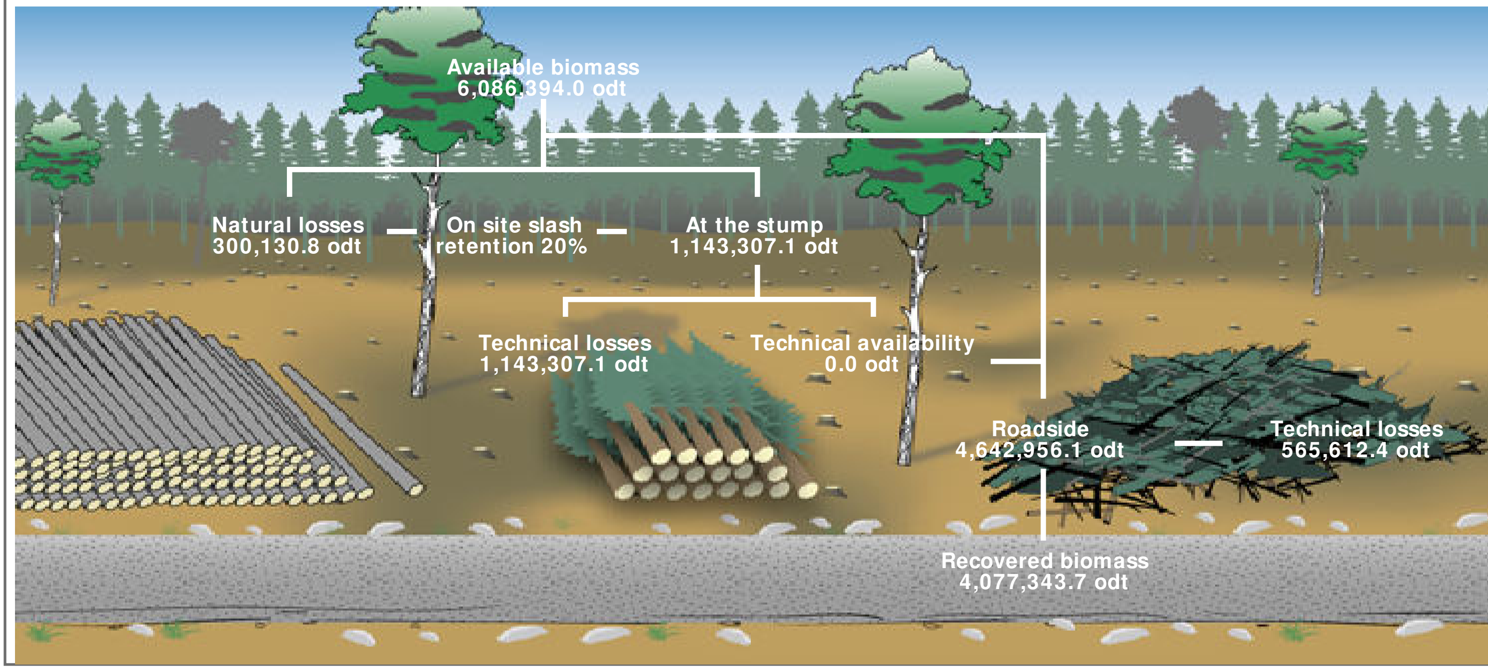
Revenue

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

Net

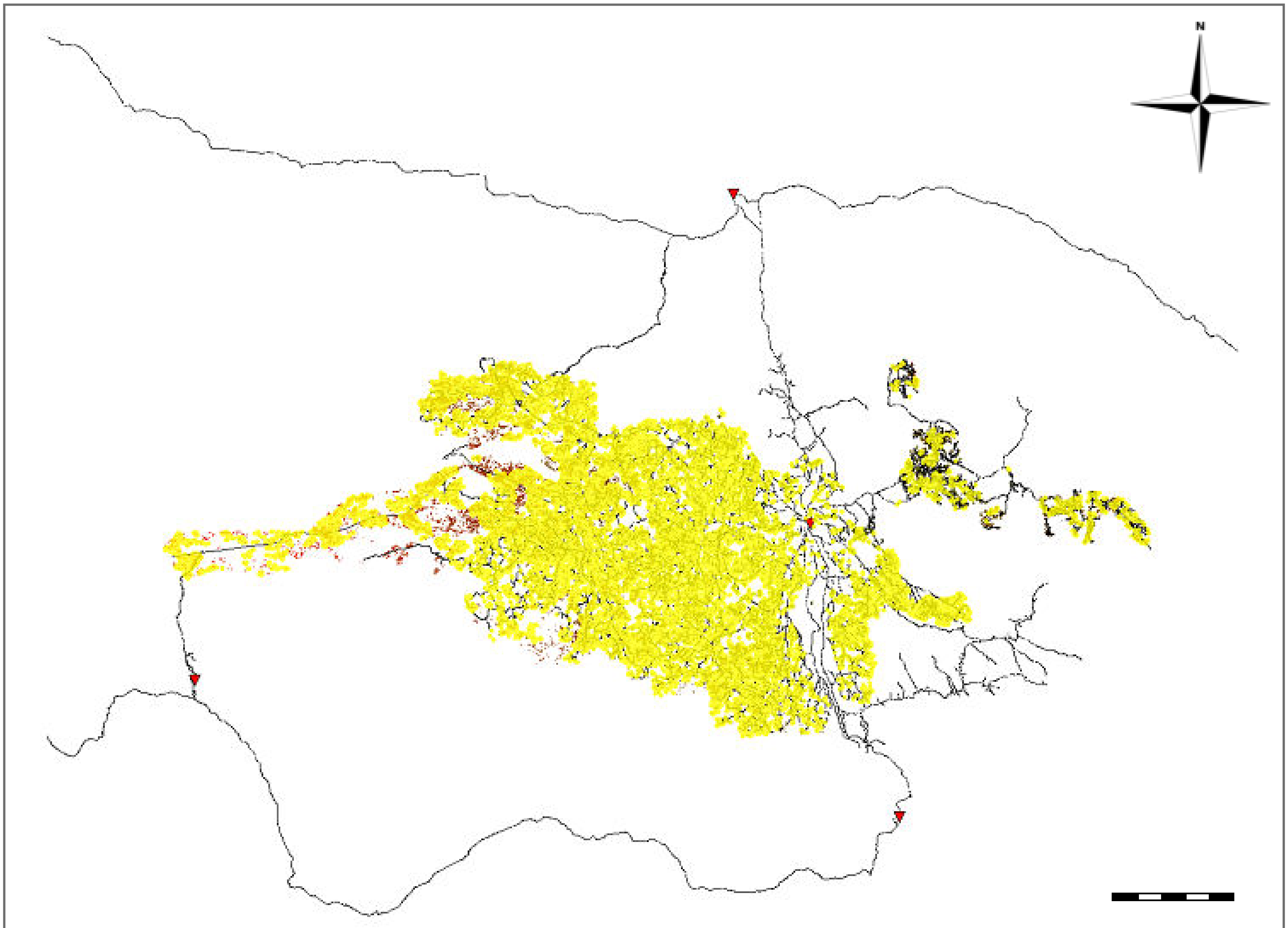
Profit	-111.13 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-- (slash)	1,401,439.9	0.1062	7.15
Lodgepole Pine-biomass	1,242,894.8	0.3829	6.34
X Spruce-- (slash)	781,285.1	0.1193	3.99
Lodgepole Pine-biomass (slash)	258,094.5	0.0913	1.32
Douglas Fir-- (slash)	162,048.1	0.0821	0.83
Trembling Aspen-- (slash)	108,184.1	0.1407	0.55
White Spruce-- (slash)	53,430.6	0.1069	0.27
Amabilis Fir-- (slash)	35,281.3	0.0923	0.18
Abies lasiocarpa-- (slash)	14,457.6	0.101	0.07
Balsam Poplar-- (slash)	7,104.1	0.0941	0.04
Western Redcedar-- (slash)	6,029.0	0.1009	0.03
White birch-- (slash)	2,997.4	0.0081	0.02
Black Spruce-- (slash)	2,741.5	0.135	0.01
Western Hemlock-- (slash)	872.2	0.0861	0
Cottonwood-- (slash)	252.3	0.1525	0
Tamarack-- (slash)	231.0	0.1704	0
	4,077,343.7		**20.81**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	4,077,343.68	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	4,077,343.68	195,976.21	3,412
• Slash freshness			
Fresh	4,077,343.68	195,976.21	3,412
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	0.00	0.00
50 $/odt	0.00	26,460.88	26,460.88
60 $/odt	0.00	370,689.45	370,689.45
70 $/odt	0.00	904,043.51	904,043.51
80 $/odt	0.00	1,303,507.30	1,303,507.30
90 $/odt	0.00	1,808,247.34	1,808,247.34
100 $/odt	0.00	2,180,527.57	2,180,527.57
110 $/odt	66.61	2,604,774.62	2,604,841.23
120 $/odt	3,689.25	2,676,251.82	2,679,941.06
130 $/odt	37,200.38	2,727,396.50	2,764,596.88
140 $/odt	151,751.20	2,786,509.25	2,938,260.45
150 $/odt	249,470.12	2,800,700.00	3,050,170.12
160 $/odt	384,230.58	2,805,672.95	3,189,903.53
170 $/odt	587,394.98	2,834,185.43	3,421,580.42
180 $/odt	788,031.42	2,834,448.91	3,622,480.32
190 $/odt	961,718.18	2,834,448.91	3,796,167.09
200 $/odt	1,079,731.84	2,834,448.91	3,914,180.74
210 $/odt	1,150,961.21	2,834,448.91	3,985,410.12
220 $/odt	1,183,371.05	2,834,448.91	4,017,819.95
230 $/odt	1,206,903.52	2,834,448.91	4,041,352.43
240 $/odt	1,221,568.99	2,834,448.91	4,056,017.90
250 $/odt	1,225,254.38	2,834,448.91	4,059,703.29

260 $/odt	1,232,114.85	2,834,448.91	4,066,563.75
270 $/odt	1,241,937.38	2,834,448.91	4,076,386.29
280 $/odt	1,242,598.90	2,834,448.91	4,077,047.81
290 $/odt	1,242,747.72	2,834,448.91	4,077,196.63
300 $/odt	1,242,860.43	2,834,448.91	4,077,309.34
310 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
320 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
330 $/odt	1,242,894.77	2,834,448.91	4,077,343.68
Maximum cost	**324.25 $/ odt**	**172.14 $/ odt**	

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	4,077,343.7 odt
Recovery rate	20.8 odt/ha
Biomass/Harvest	0.1354
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	30 : 1
Available energy	15,630,330 MWh
Fuel consumption	15 L/odt

Cost

Harvesting related costs	22.52 $/odt
Biomass recovery costs	28.48 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	39.66 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**90.66 $/ odt**

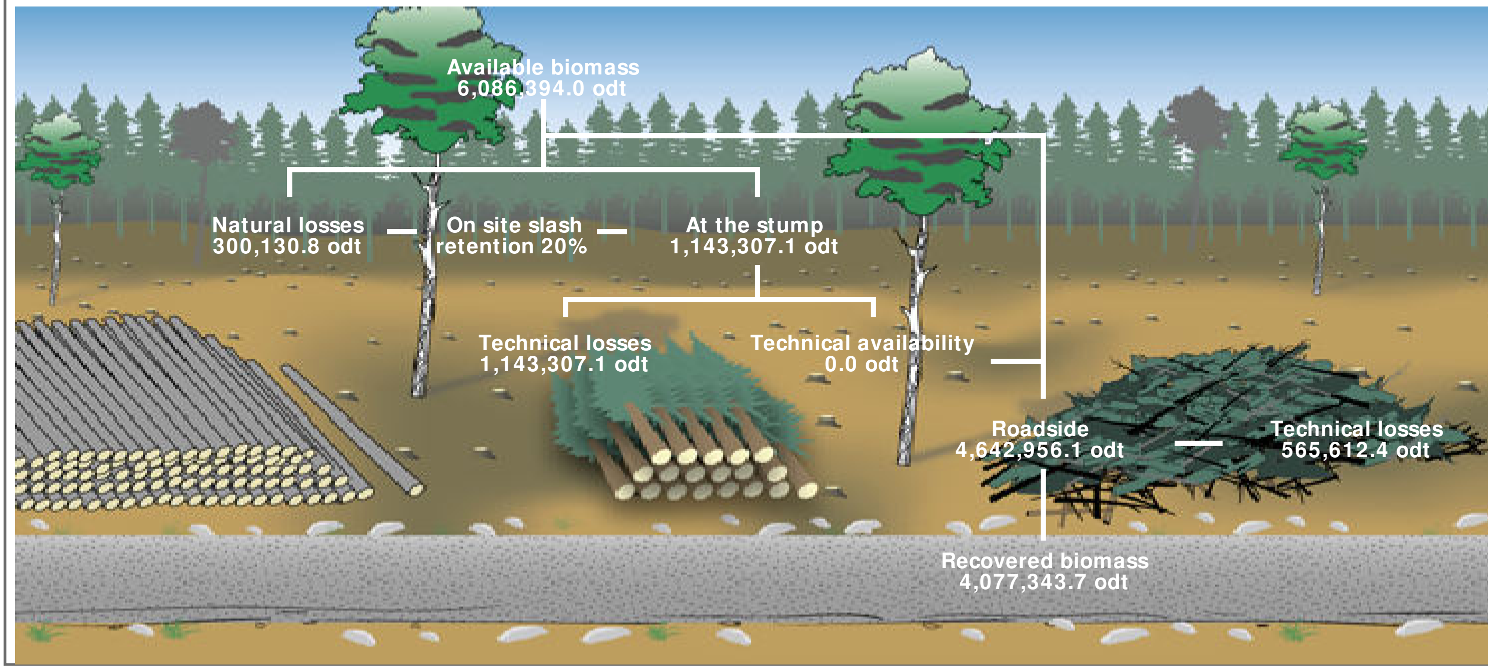
Revenue

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

Net

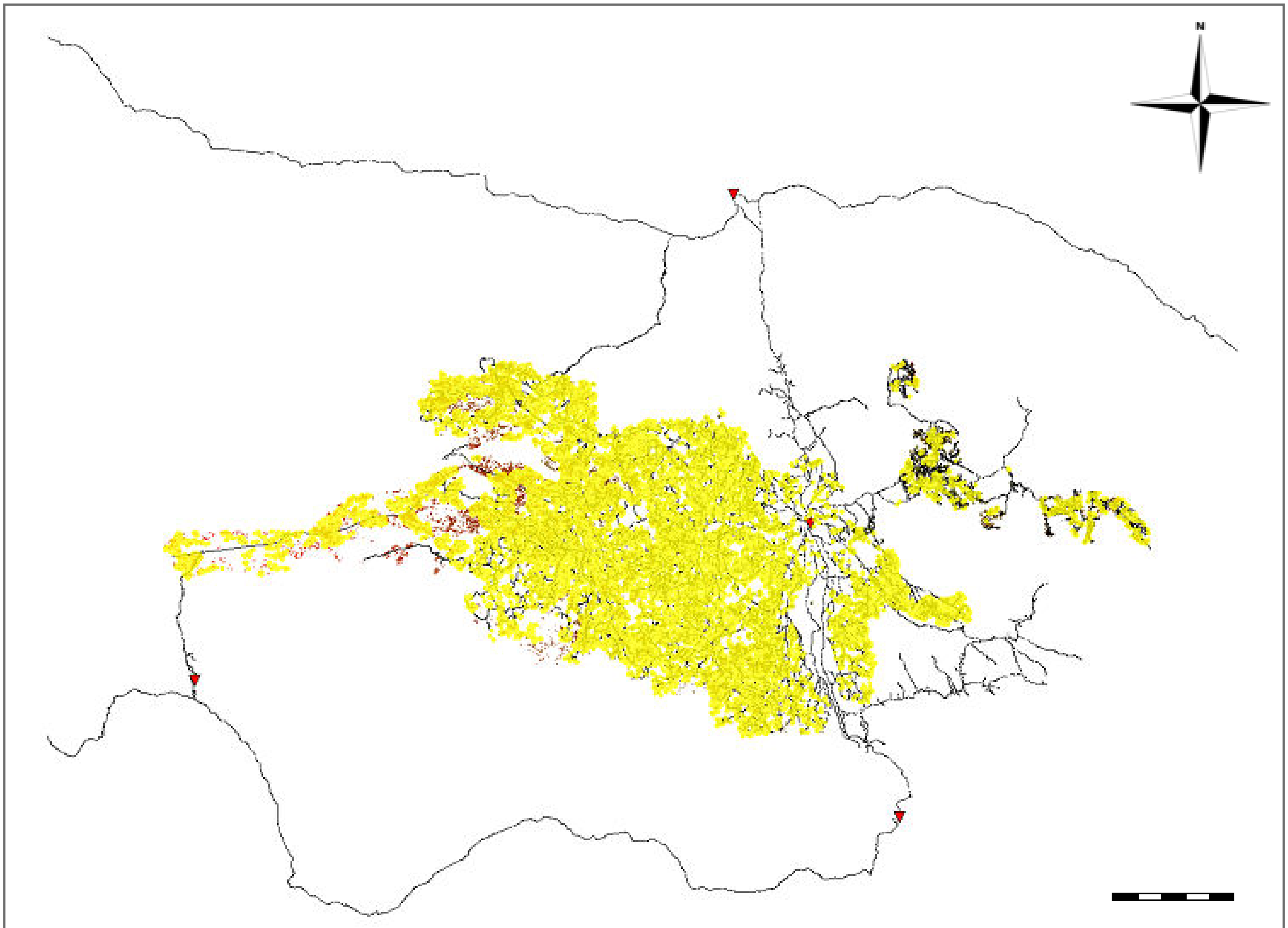
Profit	-90.66 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-- (slash)	1,401,439.9	0.1062	7.15
Lodgepole Pine-biomass	1,242,894.8	0.3829	6.34
X Spruce-- (slash)	781,285.1	0.1193	3.99
Lodgepole Pine-biomass (slash)	258,094.5	0.0913	1.32
Douglas Fir-- (slash)	162,048.1	0.0821	0.83
Trembling Aspen-- (slash)	108,184.1	0.1407	0.55
White Spruce-- (slash)	53,430.6	0.1069	0.27
Amabilis Fir-- (slash)	35,281.3	0.0923	0.18
Abies lasiocarpa-- (slash)	14,457.6	0.101	0.07
Balsam Poplar-- (slash)	7,104.1	0.0941	0.04
Western Redcedar-- (slash)	6,029.0	0.1009	0.03
White birch-- (slash)	2,997.4	0.0081	0.02
Black Spruce-- (slash)	2,741.5	0.135	0.01
Western Hemlock-- (slash)	872.2	0.0861	0
Cottonwood-- (slash)	252.3	0.1525	0
Tamarack-- (slash)	231.0	0.1704	0
	4,077,343.7		**20.81**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	4,077,343.68	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	4,077,343.68	195,976.21	3,412
• Slash freshness			
Fresh	4,077,343.68	195,976.21	3,412
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	41,338.57	41,338.57
50 $/odt	0.00	521,605.22	521,605.22
60 $/odt	0.00	1,148,529.21	1,148,529.21
70 $/odt	0.00	1,776,297.03	1,776,297.03
80 $/odt	0.00	2,228,185.86	2,228,185.86
90 $/odt	0.00	2,632,442.71	2,632,442.71
100 $/odt	2,157.64	2,724,434.98	2,726,592.62
110 $/odt	31,085.97	2,763,206.80	2,794,292.76
120 $/odt	151,241.35	2,801,644.03	2,952,885.38
130 $/odt	284,318.62	2,811,312.93	3,095,631.55
140 $/odt	458,583.68	2,834,448.91	3,293,032.59
150 $/odt	739,284.55	2,834,448.91	3,573,733.46
160 $/odt	949,814.92	2,834,448.91	3,784,263.82
170 $/odt	1,096,452.46	2,834,448.91	3,930,901.36
180 $/odt	1,167,397.75	2,834,448.91	4,001,846.66
190 $/odt	1,197,154.89	2,834,448.91	4,031,603.80
200 $/odt	1,221,676.92	2,834,448.91	4,056,125.83
210 $/odt	1,226,557.41	2,834,448.91	4,061,006.32
220 $/odt	1,238,588.83	2,834,448.91	4,073,037.73
230 $/odt	1,242,459.96	2,834,448.91	4,076,908.86
240 $/odt	1,242,587.74	2,834,448.91	4,077,036.65
250 $/odt	1,242,747.63	2,834,448.91	4,077,196.53

260 $/odt	1,242,841.54	2,834,448.91	4,077,290.45
270 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
280 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
290 $/odt	1,242,894.77	2,834,448.91	4,077,343.68
Maximum cost	**283.70 $/ odt**	**136.18 $/ odt**	

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	4,077,343.7 odt
Recovery rate	20.8 odt/ha
Biomass/Harvest	0.1354
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	30 : 1
Available energy	15,630,330 MWh
Fuel consumption	15 L/odt

Cost

Harvesting related costs	21.05 $/odt
Biomass recovery costs	29.81 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	41.03 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**91.88 $/ odt**

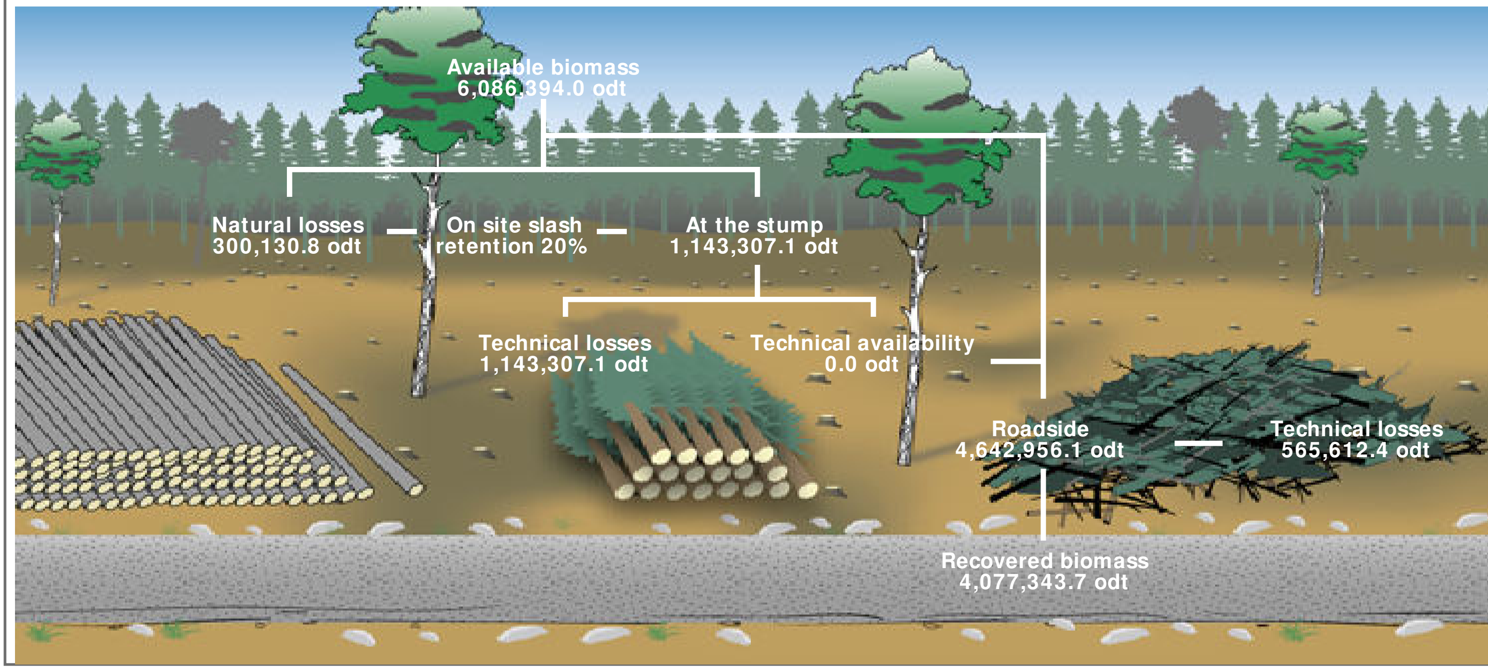
Revenue

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

Net

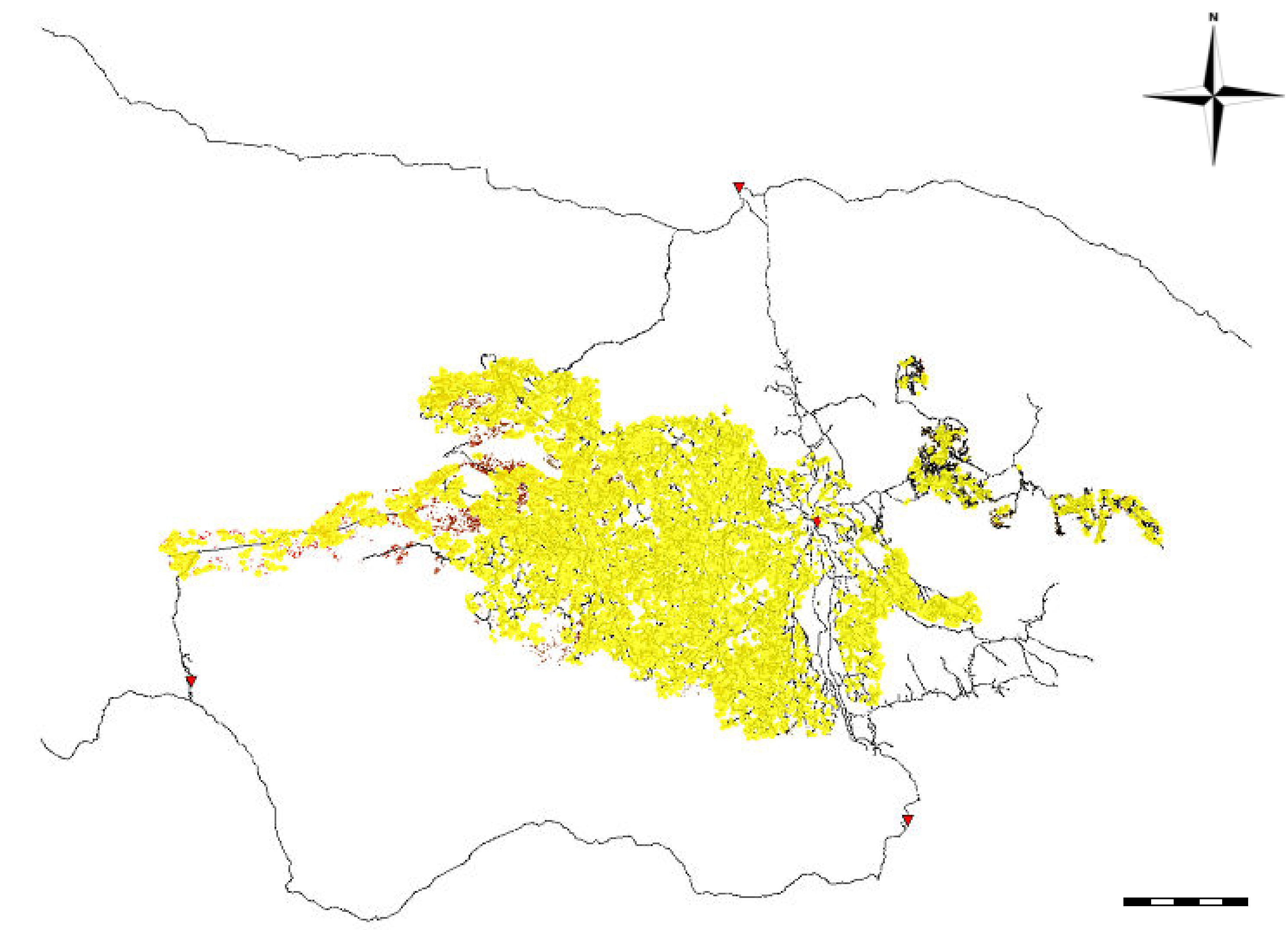
Profit	-91.88 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-- (slash)	1,401,439.9	0.1062	7.15
Lodgepole Pine-biomass	1,242,894.8	0.3829	6.34
X Spruce-- (slash)	781,285.1	0.1193	3.99
Lodgepole Pine-biomass (slash)	258,094.5	0.0913	1.32
Douglas Fir-- (slash)	162,048.1	0.0821	0.83
Trembling Aspen-- (slash)	108,184.1	0.1407	0.55
White Spruce-- (slash)	53,430.6	0.1069	0.27
Amabilis Fir-- (slash)	35,281.3	0.0923	0.18
Abies lasiocarpa-- (slash)	14,457.6	0.101	0.07
Balsam Poplar-- (slash)	7,104.1	0.0941	0.04
Western Redcedar-- (slash)	6,029.0	0.1009	0.03
White birch-- (slash)	2,997.4	0.0081	0.02
Black Spruce-- (slash)	2,741.5	0.135	0.01
Western Hemlock-- (slash)	872.2	0.0861	0
Cottonwood-- (slash)	252.3	0.1525	0
Tamarack-- (slash)	231.0	0.1704	0
	4,077,343.7		**20.81**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	4,077,343.68	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	4,077,343.68	195,976.21	3,412
• Slash freshness			
Fresh	4,077,343.68	195,976.21	3,412
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	10,616.55	10,616.55
50 $/odt	0.00	396,638.72	396,638.72
60 $/odt	0.00	1,040,897.75	1,040,897.75
70 $/odt	0.00	1,619,262.03	1,619,262.03
80 $/odt	0.00	2,104,253.86	2,104,253.86
90 $/odt	0.00	2,604,876.97	2,604,876.97
100 $/odt	3,561.70	2,691,068.42	2,694,630.12
110 $/odt	40,776.50	2,750,350.69	2,791,127.20
120 $/odt	161,903.67	2,794,537.09	2,956,440.75
130 $/odt	305,026.69	2,805,672.95	3,110,699.65
140 $/odt	514,969.32	2,834,185.43	3,349,154.75
150 $/odt	779,260.70	2,834,448.91	3,613,709.61
160 $/odt	980,839.49	2,834,448.91	3,815,288.39
170 $/odt	1,113,973.65	2,834,448.91	3,948,422.56
180 $/odt	1,170,718.19	2,834,448.91	4,005,167.10
190 $/odt	1,198,524.66	2,834,448.91	4,032,973.57
200 $/odt	1,222,167.28	2,834,448.91	4,056,616.18
210 $/odt	1,227,247.27	2,834,448.91	4,061,696.18
220 $/odt	1,238,627.83	2,834,448.91	4,073,076.73
230 $/odt	1,242,468.70	2,834,448.91	4,076,917.61
240 $/odt	1,242,598.90	2,834,448.91	4,077,047.81
250 $/odt	1,242,833.07	2,834,448.91	4,077,281.98

260 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
270 $/odt	1,242,893.66	2,834,448.91	4,077,342.56
280 $/odt	1,242,894.77	2,834,448.91	4,077,343.68
Maximum cost	**273.08 $/ odt**	**141.21 $/ odt**	

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	3,671,881.0 odt
Recovery rate	18.7 odt/ha
Biomass/Harvest	0.1219
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	29 : 1
Available energy	14,066,390 MWh
Fuel consumption	15 L/odt

Cost

Harvesting related costs	25.01 $/odt
Biomass recovery costs	31.80 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	43.30 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**100.10 $/ odt**

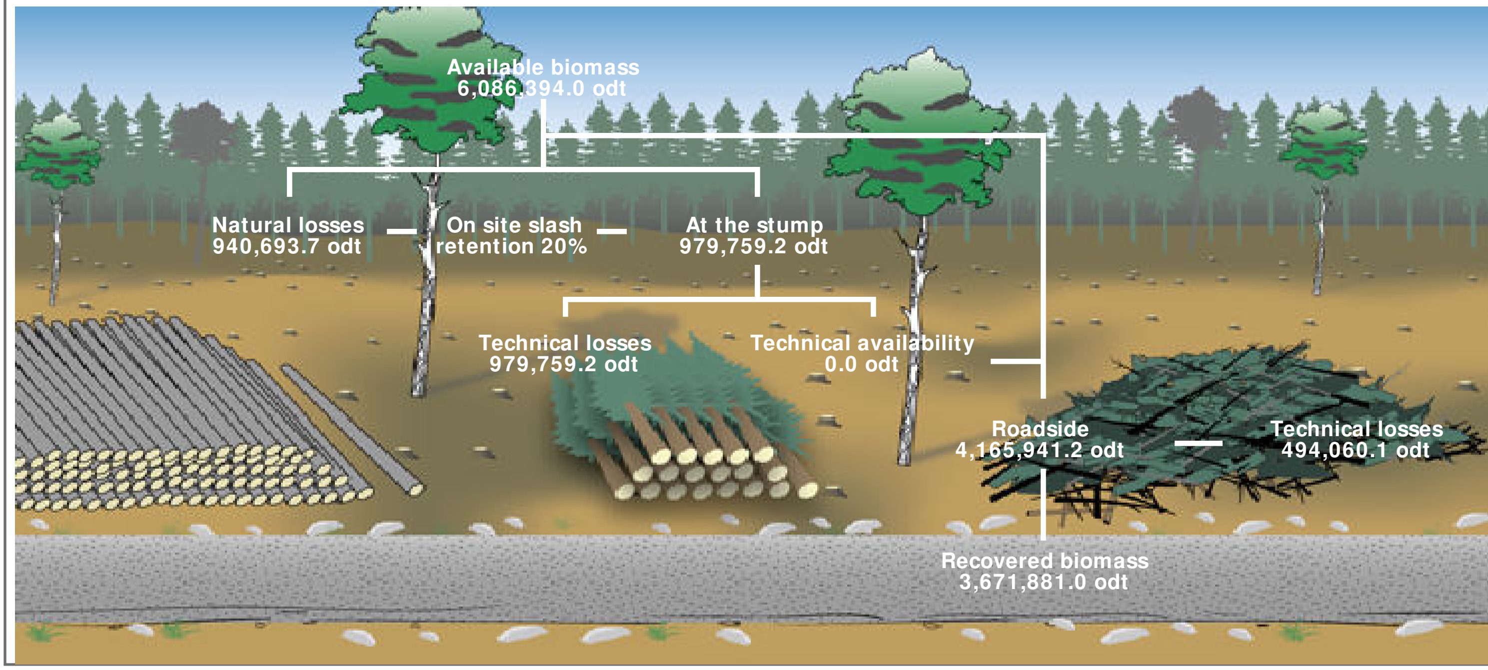
Revenue

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

Net

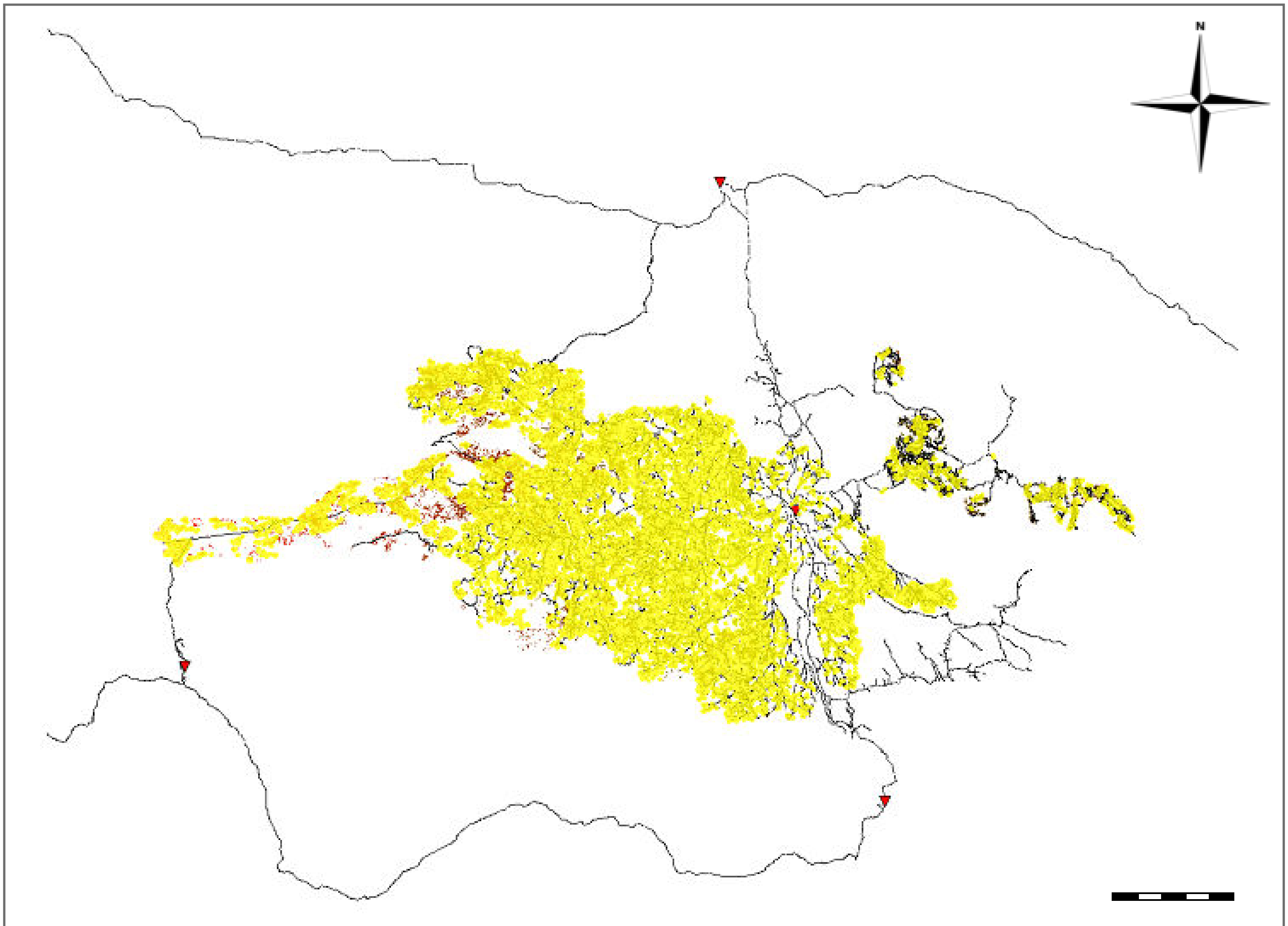
Profit	-100.10 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-biomass	1,242,894.8	0.3829	6.34
Lodgepole Pine-- (slash)	1,209,014.9	0.0916	6.17
X Spruce-- (slash)	653,889.4	0.0999	3.34
Lodgepole Pine-biomass (slash)	216,860.5	0.0767	1.11
Douglas Fir-- (slash)	138,422.8	0.0701	0.71
Trembling Aspen-- (slash)	108,184.1	0.1407	0.55
White Spruce-- (slash)	44,112.1	0.0882	0.23
Amabilis Fir-- (slash)	28,099.1	0.0735	0.14
Abies lasiocarpa-- (slash)	11,572.2	0.0809	0.06
Balsam Poplar-- (slash)	7,104.1	0.0941	0.04
Western Redcedar-- (slash)	5,156.0	0.0863	0.03
White birch-- (slash)	2,997.4	0.0081	0.02
Black Spruce-- (slash)	2,352.6	0.1159	0.01
Western Hemlock-- (slash)	755.1	0.0745	0
Cottonwood-- (slash)	252.3	0.1525	0
Tamarack-- (slash)	213.6	0.1575	0
	3,671,881.0		**18.74**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	3,671,881.01	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	3,671,881.01	195,976.21	3,412
• Slash freshness			
Fresh	0.00	0.00	0
Brown	3,671,881.01	195,976.21	3,412
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	1,026.82	1,026.82
50 $/odt	0.00	197,566.74	197,566.74
60 $/odt	0.00	737,076.24	737,076.24
70 $/odt	0.00	1,180,959.34	1,180,959.34
80 $/odt	0.00	1,685,301.85	1,685,301.85
90 $/odt	0.00	2,023,636.84	2,023,636.84
100 $/odt	165.43	2,267,300.62	2,267,466.05
110 $/odt	12,537.77	2,334,234.41	2,346,772.18
120 $/odt	61,271.42	2,367,695.11	2,428,966.53
130 $/odt	186,960.66	2,399,929.34	2,586,890.00
140 $/odt	341,416.42	2,407,776.40	2,749,192.82
150 $/odt	537,852.10	2,428,986.24	2,966,838.34
160 $/odt	788,376.05	2,428,986.24	3,217,362.29
170 $/odt	986,569.21	2,428,986.24	3,415,555.45
180 $/odt	1,107,722.99	2,428,986.24	3,536,709.23
190 $/odt	1,169,603.05	2,428,986.24	3,598,589.29
200 $/odt	1,196,596.85	2,428,986.24	3,625,583.09
210 $/odt	1,220,419.66	2,428,986.24	3,649,405.90
220 $/odt	1,225,345.86	2,428,986.24	3,654,332.10
230 $/odt	1,232,800.12	2,428,986.24	3,661,786.36
240 $/odt	1,242,459.96	2,428,986.24	3,671,446.20
250 $/odt	1,242,598.90	2,428,986.24	3,671,585.14

260 $/odt	1,242,747.63	2,428,986.24	3,671,733.87
270 $/odt	1,242,865.25	2,428,986.24	3,671,851.49
280 $/odt	1,242,893.66	2,428,986.24	3,671,879.90
290 $/odt	1,242,893.66	2,428,986.24	3,671,879.90
300 $/odt	1,242,894.77	2,428,986.24	3,671,881.01
Maximum cost	**291.17 $/ odt**	**148.76 $/ odt**	

FPInterface™

Summary report

Biomass

[ques 23mar2011 10cm]

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	3,705,367.9 odt
Recovery rate	18.9 odt/ha
Biomass/Harvest	0.1223
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	29 : 1
Available energy	14,197,533 MWh
Fuel consumption	15 L/odt

Cost

Harvesting related costs	26.16 $/odt
Biomass recovery costs	31.80 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	43.48 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**101.43 $/ odt**

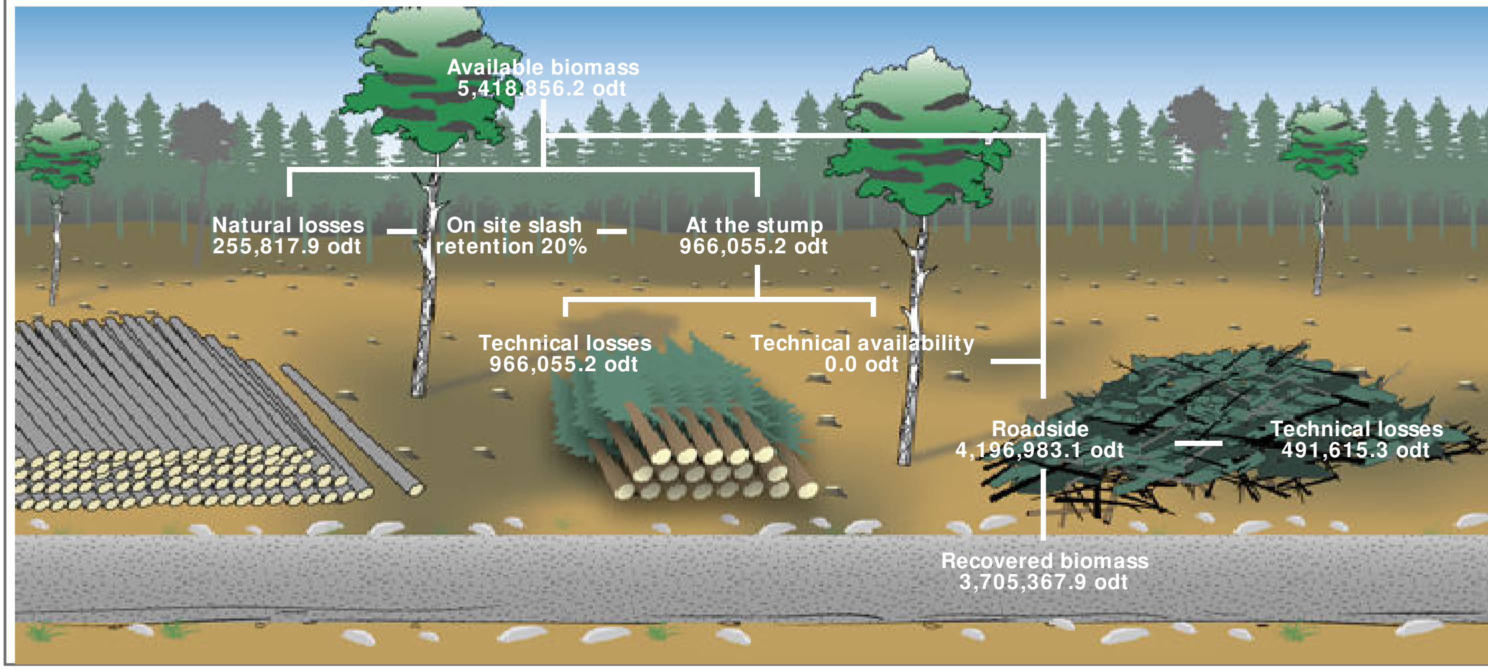
Revenue

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

Net

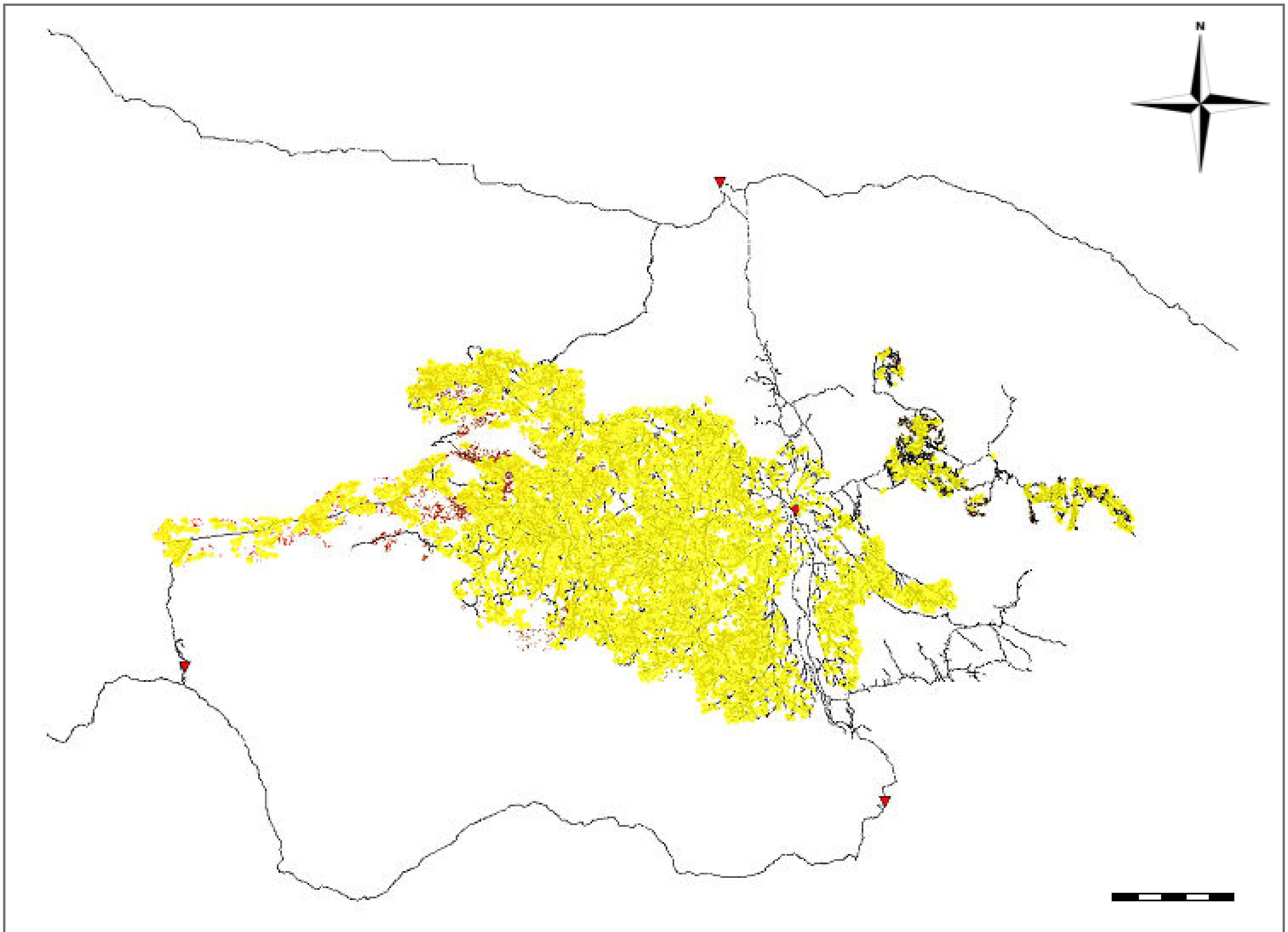
Profit	-101.43 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-biomass	1,310,356.0	0.3829	6.69
Lodgepole Pine-- (slash)	1,204,440.8	0.0913	6.15
X Spruce-- (slash)	615,287.4	0.094	3.14
Lodgepole Pine-biomass (slash)	258,094.5	0.0913	1.32
Douglas Fir-- (slash)	142,713.9	0.0723	0.73
Trembling Aspen-- (slash)	70,354.0	0.0915	0.36
White Spruce-- (slash)	43,480.0	0.087	0.22
Amabilis Fir-- (slash)	32,085.8	0.0839	0.16
Abies lasiocarpa-- (slash)	13,037.1	0.0911	0.07
Balsam Poplar-- (slash)	5,253.6	0.0696	0.03
Western Redcedar-- (slash)	4,400.1	0.0736	0.02
White birch-- (slash)	2,825.2	0.0077	0.01
Black Spruce-- (slash)	2,059.5	0.1014	0.01
Western Hemlock-- (slash)	655.4	0.0647	0
Tamarack-- (slash)	164.5	0.1213	0
Cottonwood-- (slash)	160.2	0.0968	0
	3,705,367.9		**18.91**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	3,705,367.87	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	3,705,367.87	195,976.21	3,412
• Slash freshness			
Fresh	3,705,367.87	195,976.21	3,412
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	941.28	941.28
50 $/odt	0.00	188,470.06	188,470.06
60 $/odt	0.00	719,922.83	719,922.83
70 $/odt	0.00	1,158,884.32	1,158,884.32
80 $/odt	0.00	1,657,951.07	1,657,951.07
90 $/odt	0.00	1,995,351.92	1,995,351.92
100 $/odt	169.84	2,236,892.71	2,237,062.55
110 $/odt	12,916.69	2,302,684.95	2,315,601.64
120 $/odt	63,467.56	2,334,726.00	2,398,193.56
130 $/odt	194,977.65	2,366,594.89	2,561,572.55
140 $/odt	357,307.62	2,374,310.24	2,731,617.86
150 $/odt	564,230.09	2,395,011.87	2,959,241.95
160 $/odt	828,547.86	2,395,011.87	3,223,559.72
170 $/odt	1,038,254.36	2,395,011.87	3,433,266.23
180 $/odt	1,166,823.06	2,395,011.87	3,561,834.93
190 $/odt	1,232,604.76	2,395,011.87	3,627,616.63
200 $/odt	1,261,231.98	2,395,011.87	3,656,243.85
210 $/odt	1,286,431.88	2,395,011.87	3,681,443.75
220 $/odt	1,291,643.93	2,395,011.87	3,686,655.80
230 $/odt	1,299,545.87	2,395,011.87	3,694,557.73
240 $/odt	1,309,813.21	2,395,011.87	3,704,825.08
250 $/odt	1,309,963.30	2,395,011.87	3,704,975.16

260 $/odt	1,310,136.72	2,395,011.87	3,705,148.59
270 $/odt	1,310,294.84	2,395,011.87	3,705,306.70
280 $/odt	1,310,337.71	2,395,011.87	3,705,349.58
290 $/odt	1,310,343.62	2,395,011.87	3,705,355.48
300 $/odt	1,310,346.11	2,395,011.87	3,705,357.98
310 $/odt	1,310,348.62	2,395,011.87	3,705,360.49
320 $/odt	1,310,354.65	2,395,011.87	3,705,366.52
330 $/odt	1,310,354.65	2,395,011.87	3,705,366.52
340 $/odt	1,310,354.65	2,395,011.87	3,705,366.52
350 $/odt	1,310,354.65	2,395,011.87	3,705,366.52
360 $/odt	1,310,354.65	2,395,011.87	3,705,366.52
370 $/odt	1,310,354.65	2,395,011.87	3,705,366.52
380 $/odt	1,310,356.00	2,395,011.87	3,705,367.87
Maximum cost	**373.24 $/ odt**	**148.76 $/ odt**	

FPInterface™

Summary report

Biomass

[ques 23mar2011 no stems]

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	3,176,971.6 odt
Recovery rate	16.2 odt/ha
Biomass/Harvest	0.1070
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	31 : 1
Available energy	12,279,674 MWh
Fuel consumption	15 L/odt

Cost

Harvesting related costs	0.00 $/odt
Biomass recovery costs	31.80 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	41.28 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**73.08 $/ odt**

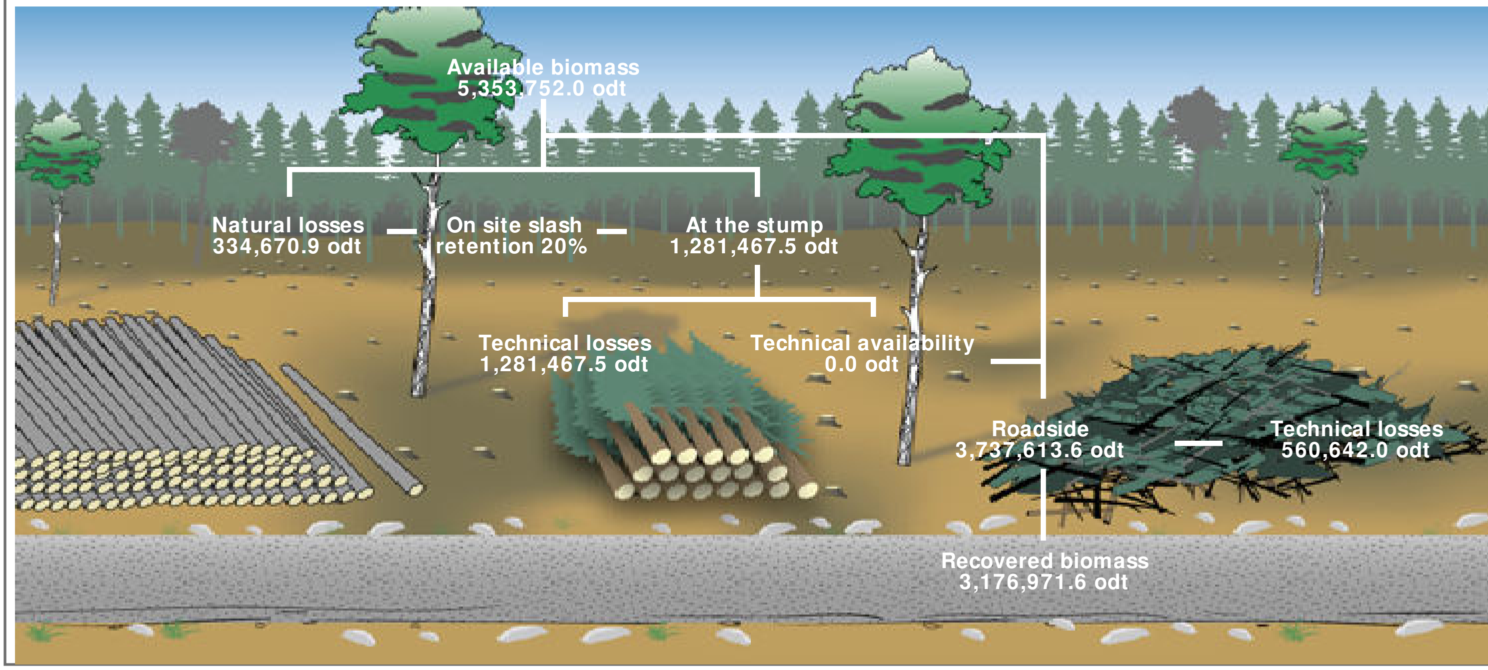
Revenue

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

Net

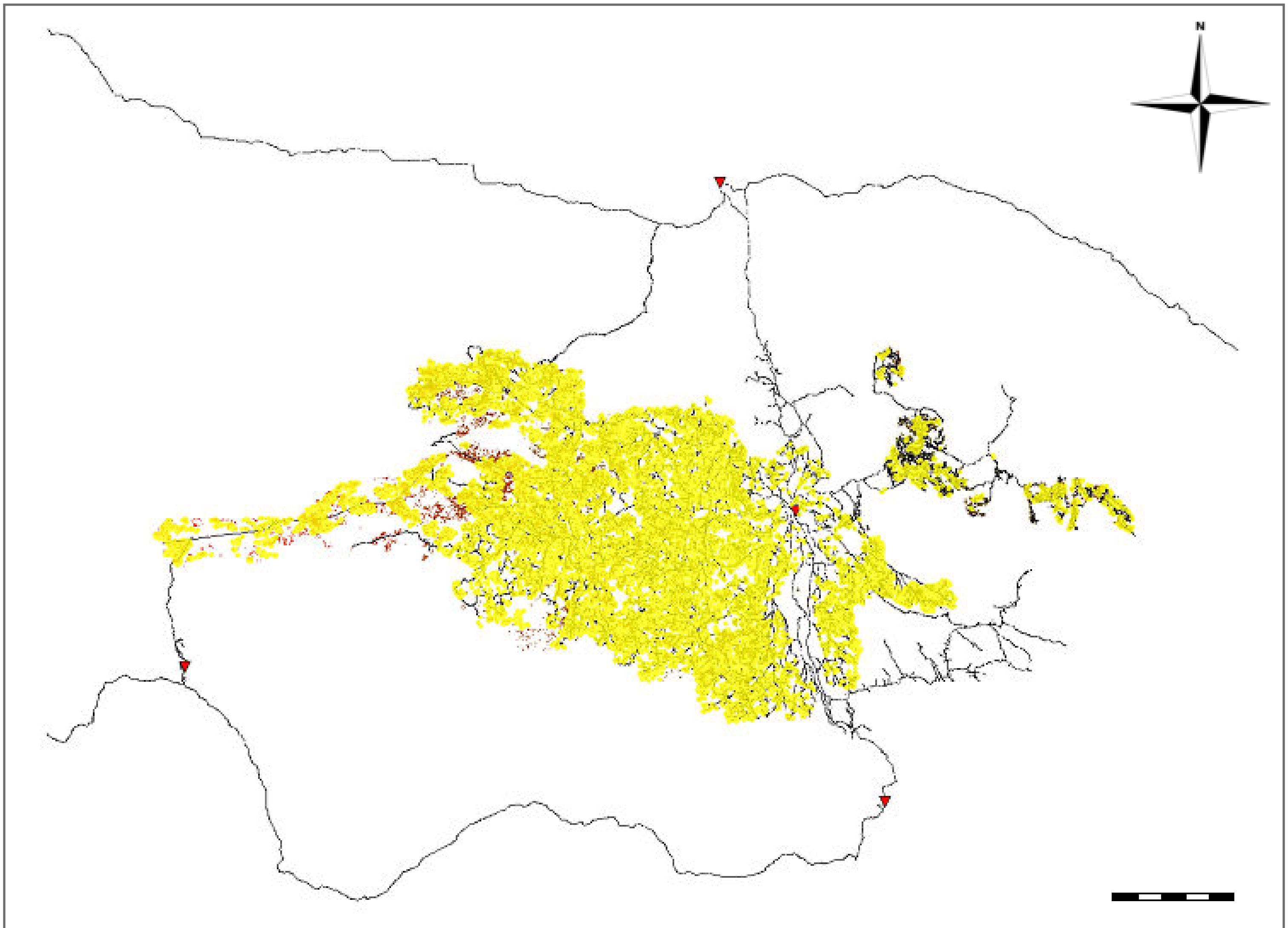
Profit	-73.08 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-- (slash)	2,002,057.0	0.1062	10.22
X Spruce-- (slash)	781,285.1	0.1193	3.99
Douglas Fir-- (slash)	162,048.1	0.0821	0.83
Trembling Aspen-- (slash)	108,184.1	0.1407	0.55
White Spruce-- (slash)	53,430.6	0.1069	0.27
Amabilis Fir-- (slash)	35,281.3	0.0923	0.18
Abies lasiocarpa-- (slash)	14,457.6	0.101	0.07
Balsam Poplar-- (slash)	7,104.1	0.0941	0.04
Western Redcedar-- (slash)	6,029.0	0.1009	0.03
White birch-- (slash)	2,997.4	0.0081	0.02
Black Spruce-- (slash)	2,741.5	0.135	0.01
Western Hemlock-- (slash)	872.2	0.0861	0
Cottonwood-- (slash)	252.3	0.1525	0
Tamarack-- (slash)	231.0	0.1704	0
	3,176,971.6		**16.21**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	3,176,971.55	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	3,176,971.55	195,976.21	3,412
• Slash freshness			
Fresh	3,176,971.55	195,976.21	3,412
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	1,194.14	1,194.14
50 $/odt	0.00	243,073.66	243,073.66
60 $/odt	0.00	929,822.40	929,822.40
70 $/odt	0.00	1,517,046.02	1,517,046.02
80 $/odt	0.00	2,186,955.87	2,186,955.87
90 $/odt	0.00	2,634,291.30	2,634,291.30
100 $/odt	0.00	2,960,876.24	2,960,876.24
110 $/odt	0.00	3,050,483.72	3,050,483.72
120 $/odt	0.00	3,094,528.16	3,094,528.16
130 $/odt	0.00	3,137,987.46	3,137,987.46
140 $/odt	0.00	3,148,500.28	3,148,500.28
150 $/odt	0.00	3,176,971.55	3,176,971.55
Maximum cost	**0.00 $/ odt**	**148.76 $/ odt**	

Summary report

Biomass

[ques 23mar2011 70% pl]

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

Statistics - Selected Items

Area	195,976 ha
Number of cut blocks	3412
Recovered biomass	2,576,354.5 odt
Recovery rate	13.1 odt/ha
Biomass/Harvest	0.1071
Delivered products	
• Chips	100 %
• Bundles	0 %
• Trunks and Slash	0 %
Energy balance	31 : 1
Available energy	9,931,489 MWh
Fuel consumption	14 L/odt

Cost

Harvesting related costs	0.00 $/odt
Biomass recovery costs	31.80 $/odt
Transfer yard cost	0.00 $/odt
Transport costs	40.64 $/odt
Stumpage fees	0.00 $/odt
Road network - Maintenance costs	0.00 $/odt
Indirect costs	0.00 $/odt
Total cost	**72.43 $/ odt**

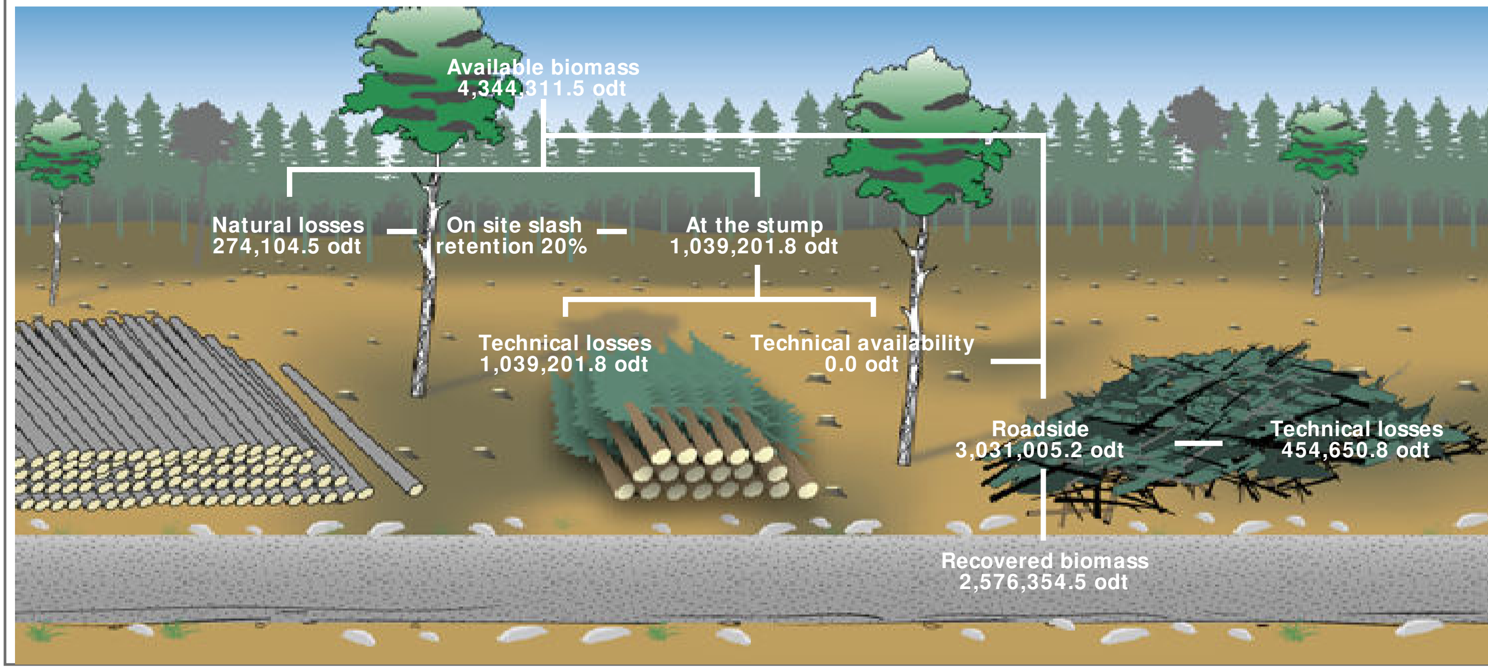
Revenue

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

Net

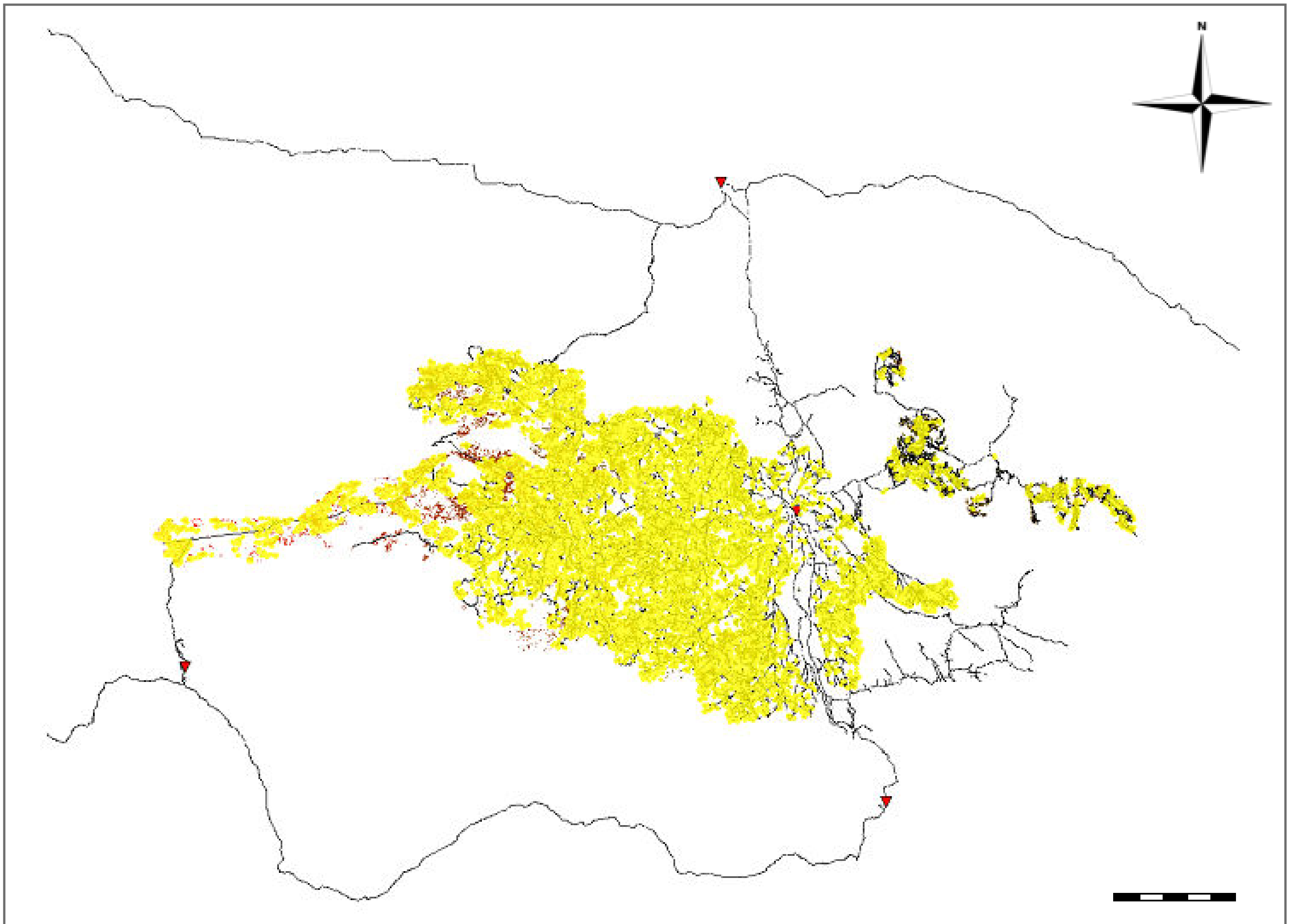
Profit	-72.43 $/odt

Flow



Products

Product name	odt	odt/ m³	odt/ ha
Lodgepole Pine-- (slash)	1,401,439.9	0.1062	7.15
X Spruce-- (slash)	781,285.1	0.1193	3.99
Douglas Fir-- (slash)	162,048.1	0.0821	0.83
Trembling Aspen-- (slash)	108,184.1	0.1407	0.55
White Spruce-- (slash)	53,430.6	0.1069	0.27
Amabilis Fir-- (slash)	35,281.3	0.0923	0.18
Abies lasiocarpa-- (slash)	14,457.6	0.101	0.07
Balsam Poplar-- (slash)	7,104.1	0.0941	0.04
Western Redcedar-- (slash)	6,029.0	0.1009	0.03
White birch-- (slash)	2,997.4	0.0081	0.02
Black Spruce-- (slash)	2,741.5	0.135	0.01
Western Hemlock-- (slash)	872.2	0.0861	0
Cottonwood-- (slash)	252.3	0.1525	0
Tamarack-- (slash)	231.0	0.1704	0
	2,576,354.5		**13.15**



3412 selected site(s) / 5077

Area covered: 195,976 ha / 251,600 ha

Recovery summary

	Volume(odt)	Area(ha)	Number of cut blocks
• Biomass recovery location			
At the stump	0.00	0.00	0
Roadside	2,576,354.46	195,976.21	3,412
• Recovery season			
Summer	0.00	0.00	0
Winter	2,576,354.46	195,976.21	3,412
• Slash freshness			
Fresh	2,576,354.46	195,976.21	3,412
Brown	0.00	0.00	0
Brittle	0.00	0.00	0

Supply summary

Recovered biomass to	Merchant wood (odt)	Slash (odt)	Total biomass (odt)
10 $/odt	0.00	0.00	0.00
20 $/odt	0.00	0.00	0.00
30 $/odt	0.00	0.00	0.00
40 $/odt	0.00	1,140.11	1,140.11
50 $/odt	0.00	213,966.95	213,966.95
60 $/odt	0.00	804,183.81	804,183.81
70 $/odt	0.00	1,268,970.83	1,268,970.83
80 $/odt	0.00	1,796,339.25	1,796,339.25
90 $/odt	0.00	2,156,572.48	2,156,572.48
100 $/odt	0.00	2,409,523.47	2,409,523.47
110 $/odt	0.00	2,478,672.46	2,478,672.46
120 $/odt	0.00	2,513,516.59	2,513,516.59
130 $/odt	0.00	2,546,508.52	2,546,508.52
140 $/odt	0.00	2,554,624.43	2,554,624.43
150 $/odt	0.00	2,576,354.46	2,576,354.46
Maximum cost	**0.00 $/ odt**	**148.76 $/ odt**	

Appendix 2

Parameters and results table from the 10-year base case and other scenarios

Appendix 3

Parameters and Results Table from the Base Case and Scenarios

Quesnel Biomass Supply - Runs Summary

run desciptor	Base Case	20 year	Williams Lake	Prince Georg	Anahim	$2 fuel	12h shift	200 d/y	brown slash	10 cm top	no stems for b	30% Pl unutiliz	yr 16-20
run name	ques 23mar2	ques 21mar2	ques 23mar2	ques 23mar2	ques 23mar2	ques 23mar2(	ques 23mar2(	ques 23mar2(	ques 23mar2	ques 23mar20	ques 23mar20	ques 23mar20	ques 23mar2011 yr16-20
Recovered biomass to $10/odt (odt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Recovered biomass to $20/odt (odt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Recovered biomass to $30/odt (odt)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Recovered biomass to $40/odt (odt)	1,164.2	2,061.8	0.0	0.0	0.0	0.0	41,338.6	10,616.6	1,026.8	941.3	1,194.1	1,140.1	713.9
Recovered biomass to $50/odt (odt)	226,613.2	282,707.9	0.0	0.0	0.0	26,460.9	521,605.2	396,638.7	197,566.7	188,470.1	243,073.7	213,967.0	24,058.2
Recovered biomass to $60/odt (odt)	858,541.4	1,154,526.2	11,197.4	0.0	0.0	370,689.5	1,148,529.2	1,040,897.8	737,076.2	719,922.8	929,822.4	804,183.8	159,330.6
Recovered biomass to $70/odt (odt)	1,375,861.9	1,856,877.9	57,157.4	6,022.3	8,682.9	904,043.5	1,776,297.0	1,619,262.0	1,180,959.3	1,158,884.3	1,517,046.0	1,268,970.8	254,340.0
Recovered biomass to $80/odt (odt)	1,964,326.3	2,556,249.9	368,513.3	156,375.0	35,482.6	1,313,507.3	2,228,185.9	2,104,253.9	1,685,301.9	1,657,951.1	2,186,955.9	1,796,339.3	296,194.4
Recovered biomass to $90/odt (odt)	2,361,977.1	3,078,681.3	906,370.9	712,306.6	71,242.1	1,808,247.3	2,632,442.7	2,604,877.0	2,023,636.8	1,995,351.9	2,634,291.3	2,156,572.5	307,195.4
Recovered biomass to $100/odt (odt)	2,646,678.9	3,515,875.1	1,406,516.2	1,270,674.0	121,481.2	2,180,527.6	2,726,592.6	2,694,630.1	2,267,466.1	2,237,062.6	2,960,876.2	2,409,523.5	318,965.1
Recovered biomass to $110/odt (odt)	2,736,972.8	3,700,366.0	1,992,696.4	1,892,074.2	193,269.9	2,604,841.2	2,794,292.8	2,791,127.2	2,346,772.2	2,315,601.6	3,050,483.7	2,478,672.5	329,113.9
Recovered biomass to $120/odt (odt)	2,824,478.2	3,830,032.4	2,396,460.2	2,336,479.5	224,604.6	2,679,941.1	2,952,885.4	2,956,440.8	2,428,966.5	2,398,193.6	3,094,528.2	2,513,513.6	338,668.3
Recovered biomass to $130/odt (odt)	2,987,660.7	4,035,112.5	3,665,116.6	2,632,426.4	281,068.4	2,764,596.9	3,095,631.6	3,110,699.7	2,586,890.0	2,561,572.6	3,137,987.5	2,546,508.5	352,485.7
Recovered biomass to $140/odt (odt)	3,151,256.1	4,219,393.6	2,744,845.2	2,715,801.0	446,174.3	2,938,260.5	3,293,032.6	3,349,154.8	2,749,192.8	2,731,617.9	3,148,500.3	2,554,624.4	357,030.9
Recovered biomass to $150/odt (odt)	3,372,301.0	4,464,029.6	2,861,486.1	2,797,604.4	667,288.9	3,050,170.1	3,573,733.5	3,613,709.6	2,966,383.3	2,959,242.0	3,176,971.6	2,576,354.5	363,229.9
Recovered biomass to $160/odt (odt)	3,622,825.0	4,726,781.7	3,010,667.1	2,951,718.7	1,116,611.8	3,189,903.5	3,784,263.8	3,815,288.4	3,217,362.3	3,223,559.7			365,422.4
Recovered biomass to $170/odt (odt)	3,821,018.1	4,948,994.7	3,137,430.0	3,089,770.2	1,686,664.0	3,421,580.4	3,930,901.4	3,948,422.6	3,415,555.5	3,433,266.2			367,315.3
Recovered biomass to $180/odt (odt)	3,942,171.9	5,160,106.3	3,318,882.9	3,276,486.5	2,214,389.0	3,622,480.3	4,001,846.7	4,005,167.1	3,536,709.2	3,561,834.9			369,595.1
Recovered biomass to $190/odt (odt)	4,004,052.0	5,262,257.0	3,582,676.5	3,543,862.8	2,549,961.8	3,796,167.1	4,031,603.8	4,032,973.6	3,598,589.3	3,627,616.6			371,141.1
Recovered biomass to $200/odt (odt)	4,031,045.8	5,314,204.4	3,790,801.1	3,754,250.7	2,878,472.6	3,914,180.7	4,056,125.8	4,056,616.2	3,625,583.1	3,656,243.9			371,333.9
Recovered biomass to $250/odt (odt)	4,077,047.8	5,384,938.8	4,075,318.6	4,057,401.2	3,386,637.2	4,059,703.3	4,077,196.5	4,077,282.0	3,671,585.1	3,704,975.2			372,928.7
Recovered biomass to $300/odt (odt)	4,077,343.7	5,385,291.4	4,077,262.6	4,077,282.0	4,072,777.6	4,077,309.3	4,077,343.7	4,077,343.7	3,671,881.0	3,705,358.0			372,929.7
Recovered biomass to $350/odt (odt)		5,385,291.8	4,077,314.2	4,077,343.7	4,077,269.3	4,077,343.7				3705366.52			372,929.0
Recovered biomass to $400/odt (odt)					4,077,342.6					3,705,367.9			
Recovered biomass to $450/odt (odt)					4,077,343.7								
All recovered biomass (odt)	4,077,343.7	5,385,291.8	4,077,343.7	4,077,343.7	4,077,343.7	4,077,343.7	4,077,343.7	4,077,343.7	3,671,881.0	3,705,367.9	3,176,971.6	2,576,354.5	372,929.0
highest biomass delivered cost ($) (slash)	$148.76	$148.76	$156.87	$180.18	$207.97	$172.14	$136.18	$141.21	$148.76	$148.76	$148.76	$148.76	$148.76
highest biomass delivered cost ($) (stems)	$291.17	$347.34	$323.18	$322.14	$409.77	$324.25	$283.70	$273.08	$291.17	$373.24			$347.34
Merchantable volume	24,045,237	32,874,043	24,045,237	24,045,237	24,045,237	24,045,237	24,045,237	24,045,237	24,045,237	24,045,237	29,699,361	24,045,237	3,215,227
Biomass ratio (2.5 m^3 / odt)	42.4%	41.0%	42.4%	42.4%	42.4%	42.4%	42.4%	42.4%	38.2%	38.5%	26.7%	26.8%	29.0%
cost compared to base case		100%	105%	121%	140%	116%	92%	95%	100%	100%	75%	74%	100%
odt at $60/odt compared to base case		134%	1%	0%	0%	43%	134%	121%	86%	84%	108%	94%	19%
odt at $90/odt compared to base case						77%	111%	110%					
percent change of parameter						160%	120%	111%	90%	77%	23%	15%	n/a
parameter changed						fuel cost	shift length	days/year	slash freshne	topping diame	stem utilizatio	stem utilizatio	topping diameter
transfer yards	Ques, PG, W	Ques, PG, WI	Ques, PG, WL	Ques, PG, WI	Ques, PG, WL	Ques, PG, WL,	Ques, PG, WL,	Ques, PG, WL,	Ques, PG, WI	Ques, PG, WL,	Ques, PG, WL,	Ques, PG, WL,	Ques, PG, WL, Anahim
year(s) analyzed	1-10	1-20	1-10	1-10	1-10	1-10	1-10	1-10	1-10	1-10	1-10	1-10	16-20
aggregate blocks	y	y	y	y	y	y	y	y	y	y	y	y	y
species attribute linking	western	western	western	western	western	western	western	western	western	western	western	western	western
road network range	Ques + hwy	Ques + hwy	Ques + hwy	Ques + hwy	Ques + hwy	Ques + hwy	Ques + hwy	Ques + hwy	Ques + hwy	Ques + hwy	Ques + hwy	Ques + hwy	Ques + hwy
road network types	version 10	version 10	version 10	version 10	version 10	version 10	version 10	version 10	version 10	version 10	version 10	version 10	version 10
biomass management activated	y	y	y	y	y	y	y	y	y	y	y	y	y
haul speeds	graduated	graduated	graduated	graduated	graduated	graduated	graduated	graduated	graduated	graduated	graduated	graduated	graduated
haul speeds at 95% / 85% of posted	y	y	y	y	y	y	y	y	y	y	y	y	y
transport shifts / day	1	1	1	1	1	1	1	1	1	1	1	1	1
transport hours / shift	10	10	10	10	10	10	12	10	10	10	10	10	10
transport days / year	180	180	180	180	180	180	180	200	180	180	180	180	180
transport fuel price / litre	$1.25	$1.25	$1.25	$1.25	$1.25	$2.00	$1.25	$1.25	$1.25	$1.25	$1.25	$1.25	$1.25
average slope	20-32	20-32	20-32	20-32	20-32	20-32	20-32	20-32	20-32	20-32	20-32	20-32	20-32

slash used for biomass	y	y	y	y	y	y	y	y	y	y	y	y	y
full stem used for biomass	n	n	n	n	n	n	n	n	n	n	n	n	n
Pl utilization of THLB merch timber	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	100%	70%	70%
Pl unutilized merch used for biomass	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	0%	0%	15%
Pl stems for biomass chipped where?	roadside	roadside	roadside	roadside	roadside	roadside	roadside	roadside	roadside	n/a	n/a	n/a	n/a
Pl merch stemwood for biomass directed where	Quesnel	Quesnel	Williams Lake	Prince Georg	Anahim	Quesnel	Quesnel	Quesnel	Quesnel	n/a	n/a	n/a	n/a
chips destination	Quesnel	Quesnel	Williams Lake	Prince Georg	Anahim	Quesnel	Quesnel	Quesnel	Quesnel	Quesnel	Quesnel	Quesnel	Quesnel
Pl stem chips have transport assigned	y	y	y	y	y	y	y	y	y	y	y	y	y
topping diameter	13 cm	13 cm	13 cm	13 cm	13 cm	13 cm	13 cm	13 cm	13 cm	10 cm	13 cm	13 cm	13 cm
truck used for chips	3-axle	3-axle	3-axle	3-axle	3-axle	3-axle	3-axle	3-axle	3-axle	3-axle	3-axle	3-axle	3-axle
truck used for logs	B-train	B-train	B-train	B-train	B-train	B-train	B-train	B-train	B-train	B-train	B-train	B-train	B-train
harvesting fuel price / litre (x3)	$1.25	$1.25	$1.25	$1.25	$1.25	$2.00	$1.25	$1.25	$1.25	$1.25	$1.25	$1.25	$1.25
harvesting shifts / day (x3)	1	1	1	1	1	1	1	1	1	1	1	1	1
harvesting hours / shift (x3)	10	10	10	10	10	10	12	10	10	10	10	10	10
harvesting days / yr (x3)	180	180	180	180	180	180	180	200	180	180	180	180	180
harvesting system	full tree	full tree	full tree	full tree	full tree	full tree	full tree	full tree	full tree	full tree	full tree	full tree	full tree
on site biomass treatment (roadside)	comminution	comminution	comminution	comminution	comminution	comminution	comminution	comminution	comminution	comminution	comminution	comminution	comminution
recovery season	winter	winter	winter	winter	winter	winter	winter	winter	winter	winter	winter	winter	winter
slash freshness	fresh	fresh	fresh	fresh	fresh	fresh	fresh	fresh	brown	fresh	fresh	fresh	fresh
slash pre-piled at roadside	y	y	y	y	y	y	y	y	y	y	y	y	y
grinder size type	horiz 600	horiz 600	horiz 600	horiz 600	horiz 600	horiz 600	horiz 600	horiz 600	horiz 600	horiz 600	horiz 600	horiz 600	horiz 600
biomass fuel price / litre (x2)	$1.25	$1.25	$1.25	$1.25	$1.25	$2.00	$1.25	$1.25	$1.25	$1.25	$1.25	$1.25	$1.25
biomass hours / shift (x2)	10	10	10	10	10	10	12	10	10	10	10	10	10
biomass shifts / day (x2)	1	1	1	1	1	1	1	1	1	1	1	1	1
biomass days / yr (x2)	180	180	180	180	180	180	180	200	180	180	180	180	180
indirect costs - biomass ($ value)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
indirect costs - harvesting ($ value)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
all polygons with 0 volume ignored	y	y	y	y	y	y	y	y	y	y	y	y	y
all polygons with less than 0.15 piece size ignored	y	y	y	y	y	y	y	y	y	y	y	y	y
all polygons (post Feb 22) smaller than 0.5 ha ignored	y	y	y	y	y	y	y	y	y	y	y	y	y
processor	i7 w ssd	i7 w ssd	i7 w ssd	i7 w ssd	i7 w ssd	i7 w ssd	i7 w ssd	i7 w ssd	i7 w ssd	i7 w ssd	i7 w ssd	i7 w ssd	i7 w ssd
FPInterface version	1.2.0.3	1.2.0.3	1.2.0.3	1.2.0.3	1.2.0.3	1.2.0.3	1.2.0.3	1.2.0.3	1.2.0.3	1.2.0.3	1.2.0.3	1.2.0.3	1.2.0.3

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ADDENDUM

June 2011

6 Addendum – June 2011

Further to the report of April 2011, more scenarios and sensitivities were attempted, specifically for trying additional power mill locations, for altering a variety of factors by 10%, and for examining biomass loss from utilizing a 4 cm top.

6.1 Other mill locations

North-south roads linking the three major road systems west of Quesnel were added to the road data set. In addition to the analyses to Williams Lake, Prince George, and Anahim Lake already completed, it was decided to analyze locations within the TSA that might be able to realize a greater volume delivered at $60/odt than Quesnel because of their central location, or that might be able to use some of the volume that was too expensive at Quesnel.

The first location is about 40 km west of Quesnel called the "bridge roads" location. The second location is the village of Nazko about 120 km west of Quesnel. The third was called the "midwest mill" and is about half way between the first two, about 75 km west of Quesnel. Amounts received at $60/odt are detailed in Table A-1.

Table A-1 Mill Location Results

Scenario	Recovered biomass at $60/odt per year	Change in recovered biomass at $60/odt
Base case	86,000	--
Mill: Bridge Roads	60,000	▼30%
Mill: Nazko	47,000	▼ 46%
Mill: Midwest Mill	43,000	▼ 50%

Additionally a determination was made of how much volume in the 10 year harvest would be optimally delivered to each location: this means how much volume is cheapest when cycled to this location. For this scenario, the Bridge Roads location was not included. The results show that most biomass has lowest cost delivery to Quesnel.

Table A-2 Lowest cost delivery point

Location	Biomass (odt) cheapest to this location	Biomass (odt) available at $60/odt (cheapest to this location)
Quesnel	1,875,000	
Midwest Mill	1,250,000	
Nazko	865,000	
Anahim Lake	72,000	
Williams Lake	8,000	
Prince George	0	

Mill Locations are shown in Figure A-1.

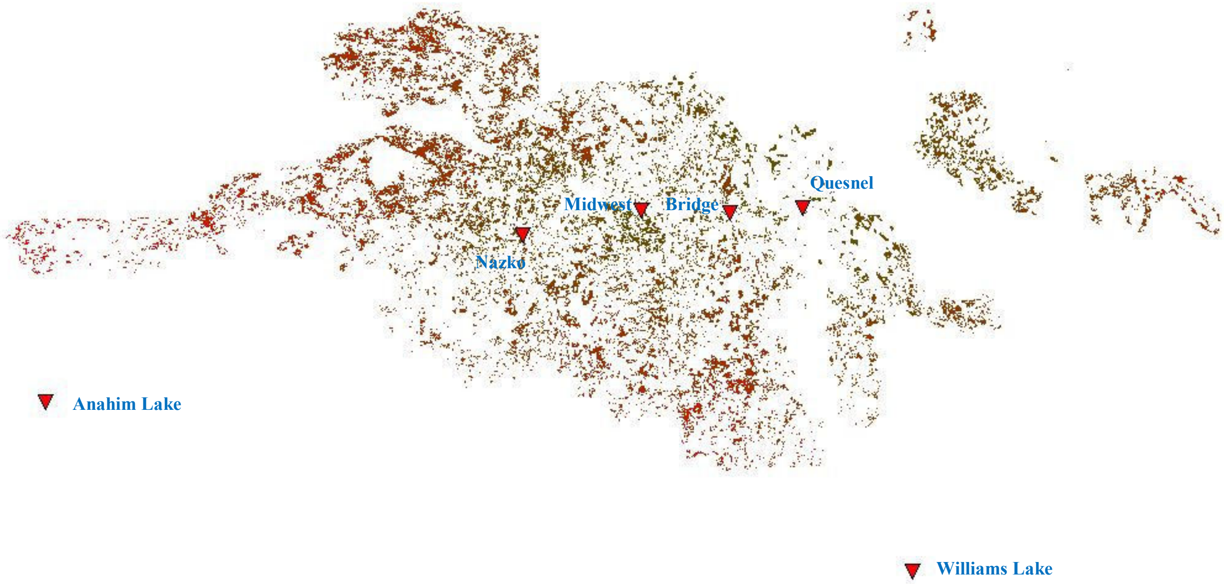

Figure A-1 Mill scenario locations

During the road snapping exercise, some roads were eliminated if they did not optimize delivery to Quesnel. It is possible that some of these eliminated roads would optimize delivery to other mill locations. Caution should therefore be exercised in interpreting these results as absolute.

6.2 Sensitivities at 10%

To show the varying impacts of different parameters, a standardized change scenario of 10% was selected. Parameters examined included working time, fuel price, road speed, overall fuel efficiency, truck fuel efficiency, grinder efficiency (utilization), and biomass recovery technical efficiency (reducing technical losses as displayed on Figure 2, *Recoverable biomass*, of the original report).

The results follow the next section in Table A-3

6.3 Topping diameter of 4 cm

Purpose-hauling comminuted biomass to Quesnel was shown to be expensive and only about 21% of total available biomass was deemed available at $60/odt in this study. However, reducing topping diameter could have the effect of allowing more biomass to be transported while still attached to the tree. This biomass could then become available for energy stock as mill residue instead of harvest residue. In the following table, Sensitivities, the difference between the base case and the 4 cm top results is 31,000 odt (at Quesnel). This is the amount that could become available as mill residue if the top diameter was lowered to 4 cm.

Table A-3 Sensitivities

Scenario: **Parameter changed**	**Recovered biomass at $60/odt per year**	**Change in recovered biomass at $60/odt**
Base case	86,000	--
4 cm top (Quesnel)	55,000	▼ 36%
10% more working time	103,000	▲ 20%
10% more fuel price	70,000	▼ 19%
10% higher road speeds	94,000	▲ 10%
10% more overall fuel efficiency	94,000	▲ 10%
10% more truck fuel efficiency	89,000	▲ 4%
10% better grinder efficiency (utilization)	96,000	▲ 11%
10 % better biomass recovery technical efficiency	94,000	▲ 10%

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