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HAIDA GWAII TIMBER SUPPLY AREA BIOMASS AVAILABILITY ESTIMATION

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Unrestricted

ABSTRACT:

The biomass yield per hectare predicted for the Haida Gwaii TSA is 19.5 oven-dried tonnes per hectare (odt/ha) from harvest residues. Over the next 20 years a total of 1.5 million odt of available biomass could be generated by harvest in the Haida Gwaii TSA, or approximately 75,000 odt/yr. Of this, 14%, approximately 2210,000 odt in total, or 11,000 odt/yr, is expected to be available at the economic price of $60 per oven-dried tonne. Delivery of biomass from the most expensive (distant) block is projected at $181/odt and the average delivered price for all biomass is $77.65/odt. Delivery location were the dryland sort sites included in use permit dataset (active and pending location) for the roundwood as well as the closest destination in between the town of Old Masset, Masset, Port Clement, Queen Charlotte, Skidegate, Sandspit, Tlell for the biomass.

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CONTRACT REPORT

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EXECUTIVE SUMMARY

Forest origin, harvest residue biomass estimates were made by FPInnovations for the Haida Gwaii Timber Supply Area (TSA), largely following the process previously established for several BC TSAs using FPInterface (2010-2020). The biomass inventory was based on 20-year harvest and road network plans for Crown land provided by the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) and excludes Tree Farm Licenses, Community Forest Agreements, and First Nations tenures. Delivery location were the dryland sort sites included in use permit dataset (active and pending location) for the roundwood as well as the closest destination in between the town of Old Masset, Masset, Port Clement, Queen Charlotte, Skidegate, Sandspit, Tlell for the biomass.

The biomass yield per hectare predicted for the Haida Gwaii TSA is 19.5 oven-dried tonnes per hectare (odt/ha) from harvest residues.

The biomass ratio, which is the ratio of recoverable biomass to recoverable merchantable roundwood, is estimated at 11.2%. Over the next 20 years a total of 1.5 million odt of available biomass could be generated by harvest in the Haida Gwaii TSA, or approximately 75,000 odt/yr. Of this, 14%, approximately 221,000 odt in total, or 11,000 odt/yr, is expected to be available at the economic price of $60 per oven-dried tonne. Delivery of biomass from the most expensive (distant) block is projected at $181/odt and the average delivered price for all biomass is $77.65/odt. (Table 4 from the text, follows.)

Biomass available	
up to $60/odt	total ($181/odt)
220,827 odt	715,447 odt
per year	per year
11,041 odt	35,772 odt

Because the TSA is located on an island, economic availability of biomass (> $60/odt) is highly dependent on the logistics and transportation costs to the desired local delivery point, as well as the cost of transportation to potential markets located on the mainland. This report is overlooking a planification horizon for the next 20 years divided by 4 periods of 5 years, starting in 2022. The biomass yield per hectare remained relatively constant through the four time periods and averaged 19.5 odt/ha. The amount of biomass available in periods 1 is consistently higher than any other period through the 20-year period, averaging 30% more biomass available. However, period 3 shows significantly less availability of biomass at the economic price points of $60/odt than the other periods. This means that more period 3 blocks are geographically farther from the delivery point than in the other periods.

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1. INTRODUCTION

Forest origin, harvest residue biomass estimates were made by FPInnovations for the Haida Gwaii Timber Supply Area (TSA), largely following the process previously established for previous BC TSAs using FPInterface (2010-20). The biomass inventory was based on 20-year harvest and road network plans for Crown land provided by the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) and excludes Tree Farm Licenses (TFLs), Community Forest Agreements (CFAs), and First Nations tenures. Detailed introductory statements applying to this project and the greater project as a whole may be found in the report "Estimating Quesnel Biomass Supply Using FPInterface®." It is hoped that the information in this report will assist in understanding biomass availability for industrial proposals.

2. OBJECTIVE

The objective of the project was to calculate the cost of forest-origin biomass as a feedstock in the Haida Gwaii TSA.

Specific deliverables include:

a. An analysis showing the delivered cost of biomass from point of origin; and
b. An analysis showing the amount of biomass delivered at different price points. A value of $60 for one oven-dried tonne (odt) is regarded as the market value for biomass, in accordance with the previous analyses.

3. METHODS

3.1 Overall process

The basic methodology for determining biomass supply in western Canada was established during analysis of the Quesnel and Williams Lake Timber Supply Areas (TSAs). It is reviewed below.

The analysis focused on the Haida Gwaii TSA and was based on polygon data (tree characteristics) and a road data set supplied by the Ministry. It did not include any nearby woodlots, CFA's, or any First Nations tenures. Including some of these areas could alter the available supply of biomass.

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

The following process map (Figure 1) graphically displays the steps taken to build the final inventory of economically available biomass for the Quesnel TSA. A similar process was used for the Haida Gwaii TSA.

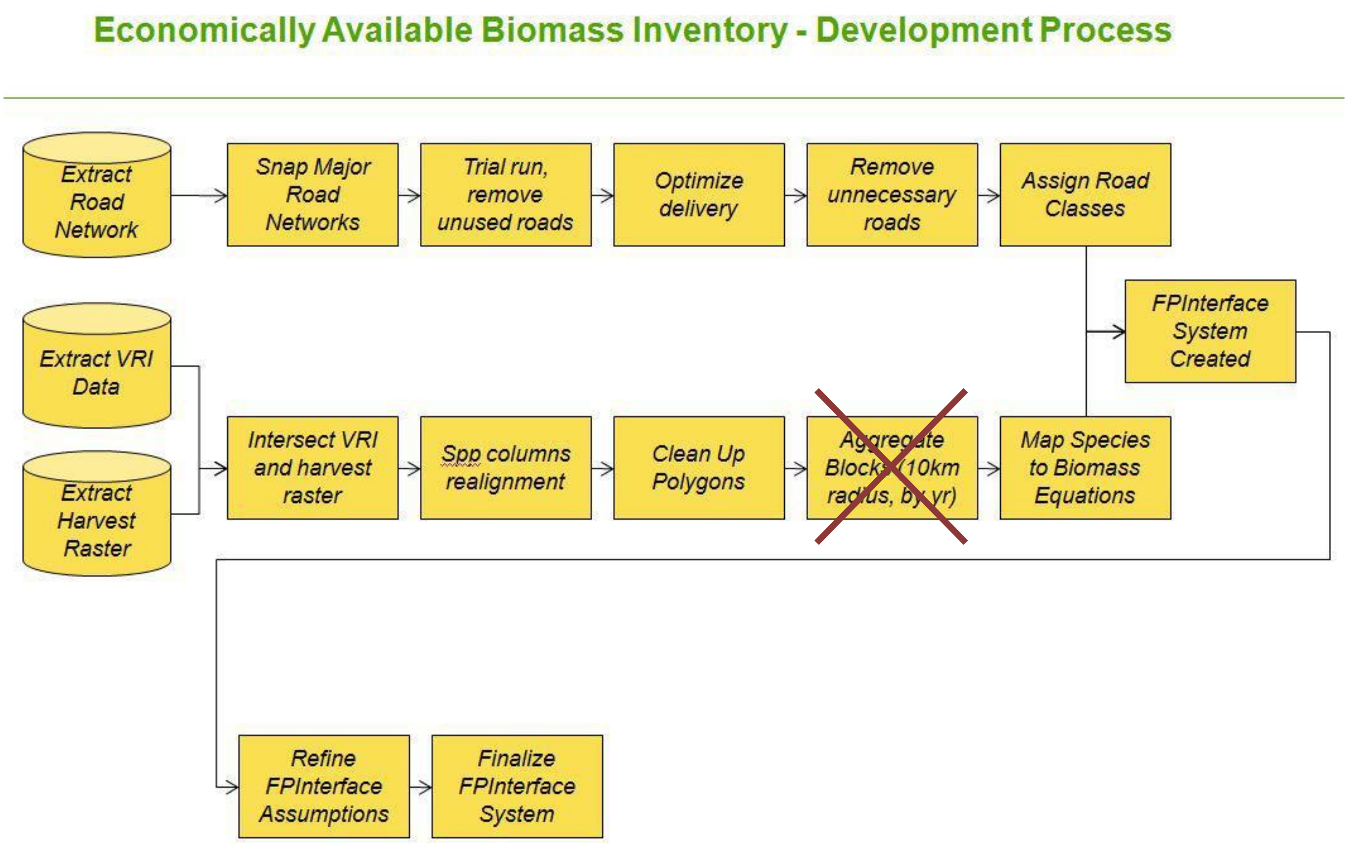

Figure 1. Inventory development process for economically available biomass.

3.2 Data acquisition

Data layers were acquired from the Ministry for the Haida Gwaii TSA (excluding woodlots, CFA areas, and any First Nations tenure areas), including VRI (Vegetation Resource Inventory) polygons with attributes, and road linework with attributes. The polygon data was for 20 years of harvest in four, five-year periods. The polygon data was already populated with species and volume information for each polygon.

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

3.3 Data transformation

FPInterface requires two major inputs – a polygon layer of harvestable blocks with attributes, and a road layer. The polygon layer must also have a harvest raster built into it, indicating which polygons are to be cut in which time period. To calculate biomass amounts, FPInterface requires volume/species/ha or total volume/species/block in each polygon. To be more precise you can input the volume/species/stem if available, although generic data is provided by the software. When the polygon layer is uploaded it is necessary to tie species in the resultant to FPInterface species.

In order to speed calculations, polygons with little or no merchantable volume were removed from the resultant. Some of these polygons resulted from the process of intersecting the VRI and the harvest raster layers. Aggregation rules meant some blocks were grouped if they had an identical harvest period. Because of the update of FPInterface software it is now possible to process more polygons in a reasonable time. Therefore, the aggregation of blocks is not necessary anymore.

FPInterface calculates cost in part by finding a transport route from product origin in a polygon (block) to the mill or delivery site. Road classes are necessary. FPInterface uses the shortest and fastest route using speed according to road class/speed. 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 block and mill or may find a sub-optimal circuitous path.

Examination of the received data set showed that road snapping was required. A program was used to identify gaps in the road network and close them.

3.4 Biomass equations

To perform the analysis, tree species indicated in the inventory are tied to single-tree biomass equations in FPInterface. For the Quesnel analysis in 2010-11, these equations were based on “Canadian national tree above ground biomass equations” by Lambert, M.C., C.H. Ung, and F. Raulier, 1996-2008. Although this equation set includes trees from all across Canada including western and northern Canada, there were very few samples from BC. More recently, Lambert et al. have released tree equations for BC (accepted by the BC ministry) and these were incorporated into FPInterface for the Williams Lake and subsequent analyses, including this one.

3.5 FPInterface parameters

3.5.1 Tree species associations

Species associations were made as follows in Table 1.

Table 1. Species associations

FPInterface species	System label	Named	Original data set
Spruce, Sitka	SX	Sitka spruce	SX
Spruce, Sitka	SS	Sitka spruce	SS
Alder, red	DR	Red alder	DR
Pine, lodgepole	PLC	Lodgepole pine	PLC
Cedar, western red	CW	Western redcedar	CW
Hemlock, western	HW	Western hemlock	HW
Cedar, yellow	YC	Yellow cedar	YC

3.5.2 Road classes

The road dataset contained road class names that could be associated with road classes in FPInterface. FPInterface road classes can then be assigned speeds based on truck configuration. Hauling comminuted fibre was assigned to a 3-axle chip truck and logs were assigned to B-train logging trucks. One set of speeds was assigned regardless of truck configuration and then following Interior Appraisal Manual (IAM) methodology, 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

Ministry road class	FPInterface road class	Road speed (95% / 85%*)
Highway	Paved	90 km/h (86 / 77)
Arterial	Class 1	70 km/h (67 / 60)
Collector	Class 2	50 km/h (48 / 43)
Local	Class 2	50 km/h (48 / 43)
Resource	Class 3	40 km/h (38 / 34)
Unclassified	Class 3	40 km/h (38 / 34)
Ferry	Class 4	20 km/h (19 / 17)
BoatFPI	Class 4	20 km/h (19 / 17)
Skid	Class 4	20 km/h (19 / 17)
Strata	Class 4	20 km/h (19 / 17)
Runway	Class 5	20 km/h (19 / 17)
Service	Class 5	20 km/h (19 / 17)
Alleyway	Class 5	20 km/h (19 / 17)
Lane	Class 5	20 km/h (19 / 17)
Driveway	Class 5	20 km/h (19 / 17)
Yield	Class 5	20 km/h (19 / 17)

* percent of posted speed

3.5.3 General parameters

The price of fuel can have significant impacts on model results. Some equipment in the model can use diesel and some is eligible for marked fuel. A price of $1.60/litre was assigned which is slightly higher than current rates for diesel but approximates a medium-term average, plus gas prices on Haida Gwaii are always higher due to transportation.

The program's default values for productivities and costs of forestry equipment rely on FPInnovations studies and information. If a user 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, only the default values were used.

Average slope for the area was assigned to CPPA Class 3 (20-32%). Ground strength was rated CPPA Class 4 (poor), and ground roughness was rated CPPA Class 4 (rough).

3.5.4 Comminution cost

Working time for BC conditions was based on previous base case studies and consists of one 12-hour shift per day, 200 days per year. Grinder utilization was set at 60% and fuel used per productive machine-hour for the grinder was the standard 150 L/PMH (litres per productive machine hour). These are the standard base case parameters used in past FPInnovations studies and enable comparisons to those studies. Here, they produced a grinding cost of $33.00/odt.

3.5.5 Topping diameter

Although BC regulations require a topping diameter of 10.0 cm for most merchantable species, this analysis used 12.5 cm to reflect more common industrial practise. Topping diameter can have a significant impact on the volume of a tree available for biomass use.

3.5.6 Parameters as entered into FPInterface

A summary of some of the parameters as entered into FPInterface follows for the base case, which produces grinding costs of $33.00/odt (Table 3). A transfer yard located in Prince Rupert was estimated to have a transportation cost of $16.00/m³, whereas other transfer yards had an average cost for handling wood estimated at $1.00/m³ [1].

Table 3. FPInterface parameters

Run descriptor	Base case - default grinding efficiency
run name	Haida Gwaii 2022
output name	Biomass – Haida Gwaii
block system	Blocks_TSA25.shp
road system	Roads_TSA25.shp
transfer yard(s)	location from the use permit dataset including active and pending dryland sort yard as well as Prince Rupert and Moresby Island
cost per transfer yard, respectively	$1.00/m³
year(s) analyzed	All
species attribute linking	BC
automatic assignment of road class by volume	No – by road class
road maintenance	Yes
haul speeds	Graduated
haul speeds at 95% / 85% of posted	Yes
transport shifts / day	1
transport hours / shift	12
transport days / year	200

[1] Stated in *Socio-Economic Analysis in support of the Haida Gwaii Timber Supply Review* prepared by Crane Management Consultants Ltd. Nov. 2019. http://www.haidagwaiimanagementcouncil.ca/wp-content/uploads/2019/11/HG-TSR-socio-ec-report_Crane_HG-TSR-socio-ec-report_Crane_Nov12_2019.pdf

transport fuel price / litre	$1.60
ground strength	4 - poor
ground roughness	4 - rough
average slope %	20-32
slash used for biomass	Yes
full stem used for biomass	No
chip destination	Old Masset, Masset, Port Clement, Queen Charlotte, Skidegate, Tlell, Prince Rupert, Moresby Island, Sandspit
topping diameter	12.5 cm
truck used for logs	Tridem B-train
truck used for chips	3-axle
harvesting fuel price / litre (x3)	$1.60
harvesting shifts / day (x3)	1
harvesting hours / shift (x3)	12
harvesting days / year (x3)	200
harvesting system	full tree with roadside processing
felling & processing	mechanized and bunched
skid type	skidder with grapple
type of roadside processing	cut-to-length
on site biomass treatment (roadside)	Comminution
recovery season	Winter
slash freshness	>3 months
slash pre-piled at roadside	Yes
grinder size type	horizontal 600 kW
biomass fuel price / litre (x2)	$1.60
biomass hours / shift (x2)	12
biomass shifts / day (x2)	1
Biomass days / year (x2)	200
grinder efficiency	60%
Grinder fuel use (L/PMH)	150
indirect costs - biomass ($ value)	$0.00
indirect costs - harvesting ($ value)	$0.00

3.6 Delivery locations

All harvest residues from in-woods operations (not from mills) were directed to dryland sort in or near the Haida Gwaii TSA. In this model, delivery locations for biomass were the town of Old Masset, Masset, Port Clement, Queen Charlotte City, Skidegate, Tlell, Prince Rupert, Moresby Island and Sandspit. Initial comminution was set to take place at roadside, and costs are calculated for biomass delivered to the delivery locations.

3.7 Biomass calculations

The biomass calculations in FPInterface produce a volume of total available biomass once merchantable roundwood has been removed. For this project, only biomass transported to roadside was considered recoverable while biomass likely to remain at the stump or dispersed on the cutblock was not. Once it is transported to roadside, some biomass becomes unavailable due to handling and technical losses. The remainder is considered recovered biomass. Figure 2 shows this breakdown with the numbers from the 20-year harvest of the base case with normal grinder utilization of 60% and fuel usage of 150 L/PMH.

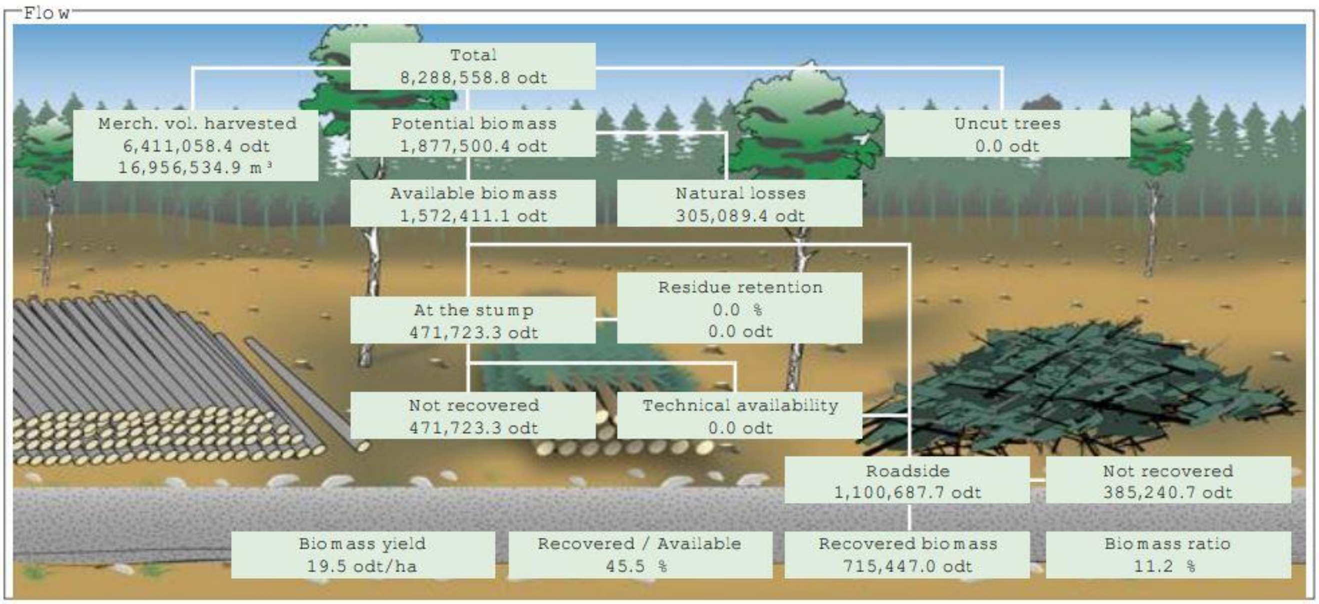

Figure 2. Recoverable biomass at delivery locations.

4. RESULTS AND DISCUSSION

4.1 Summary of key results

All results from the different runs performed in FPInterface are summarized in Appendix 1. The FPInterface analysis of biomass supply in the Haida Gwaii TSA, based on inventory information and the road network supplied by the Ministry, indicates an average biomass yield of 19.5 oven-dried tonnes (odt) per hectare for the base case. This is in the form of comminuted hog fuel and comes from harvest residues only – tops, branches, and other roadside logging waste. Mill residues are not predicted by the model. Biomass yield is shown in Figure 2 and is estimated to be 19.5 odt/ha.

4.2 Biomass volumes

In total, for the base case (all periods) there are predicted to be 715, 477 odt that could be recovered from roadside and delivered to the delivery locations over the course of 20 years. The amount of biomass available each year is approximately 35,700 odt/yr, with the highest cost being $181.21/odt. The amount of biomass available in each five-year period varies from 31,600 odt/yr in period 4 to 41,400 odt/yr in period 1. The economically available volume at $60/odt is estimated at 11,000 odt/yr, as described below. Key amounts of biomass availability are shown in Table 4.

Table 4. Key availability volumes

Biomass available	
up to $60/odt	total ($181/odt)
220,827 odt	715,447 odt
per year	per year
11,041 odt	35,772 odt

The biomass available at $90/odt is evaluated at 81% of the total recovered biomass, whereas the biomass available at the perceived economic rate of $60/odt s 31% of the total recovered biomass. This means that if demand for biomass is high, much more can become available if purchasers are willing to pay more.

Additionally, the model indicates that there are about 1,877,500 odt of potential biomass that would be left on the cutblock after the primary harvest of which 776,800 odt would not make it to roadside. This 776,800 odt includes material that falls off trees naturally and material that breaks off timber and is left on the ground during normal harvesting operations. The amount of biomass left at the stump is evaluated to be about 471,700 odt, out of which we could potentially increase the recovered biomass by recovering a greater volume of this biomass left at the stump. This vast amount of volume left on site is much higher than that deemed necessary to replenish the forest floor and prevent nutrient degradation to the soil. Additionally, 385,240 odt of biomass material that makes it to roadside is not recovered due to technical handling efficiencies, that is, the material is too small or large for machine handling or is incorrectly positioned for economic accessibility.

4.3 Biomass ratio

The biomass ratio (BR) is the ratio of recoverable biomass to recoverable merchantable roundwood. The BR is 11.2% for the all-period scenario. In this case 6,411,058 odt of roundwood (17 M of m^3) are expected along with 715,447 odt of biomass. The BR is shown in Table 5.

Table 5. Biomass ratio

Biomass Ratio	
715,447	odt of biomass
6,411,058	odt of roundwood
11.2%	

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

4.4 Cost availability

FPInterface breaks down the available supply into delivered cost in $10 increments. At the presumed market rate of $60/odt, the amount available over 20 years is predicted at 715,447 odt or about 35,772 odt per year. The complete results in $10 increments for the entire 20-year period can be seen below in Table 6 and Figure 3.

Table 6. Haida Gwaii TSA biomass 'cost-availability' for all periods

Base case		
Cost $/odt	Odt available	Odt/year
10	-	-
20	-	-
30	-	-
40	43,321	2,166.1
50	59,933	2,996.6
60	220,827	11,041.4
70	388,403	19,420.1
80	538,851	26,942.5
90	577,719	28,885.9
100	602,774	30,138.7
110	606,253	30,312.6
120	606,253	30,312.6
130	608,557	30,427.9
140	640,861	32,043.1
150	664,423	33,221.1
160	680,411	34,020.6
170	703,481	35,174.1
180	714,997	35,749.8
190	715,447	35,772.4
200	-	-

The volume at each price point are cumulative. It means that the volume available at $60/odt, for example, includes all the biomass at $50/odt plus the additional biomass available between $50 and $60 per odt.

Because the TSA is located on an Island, economic availability of biomass (> $60/odt) is highly dependent on the logistics and transportation costs to the desired local delivery point.

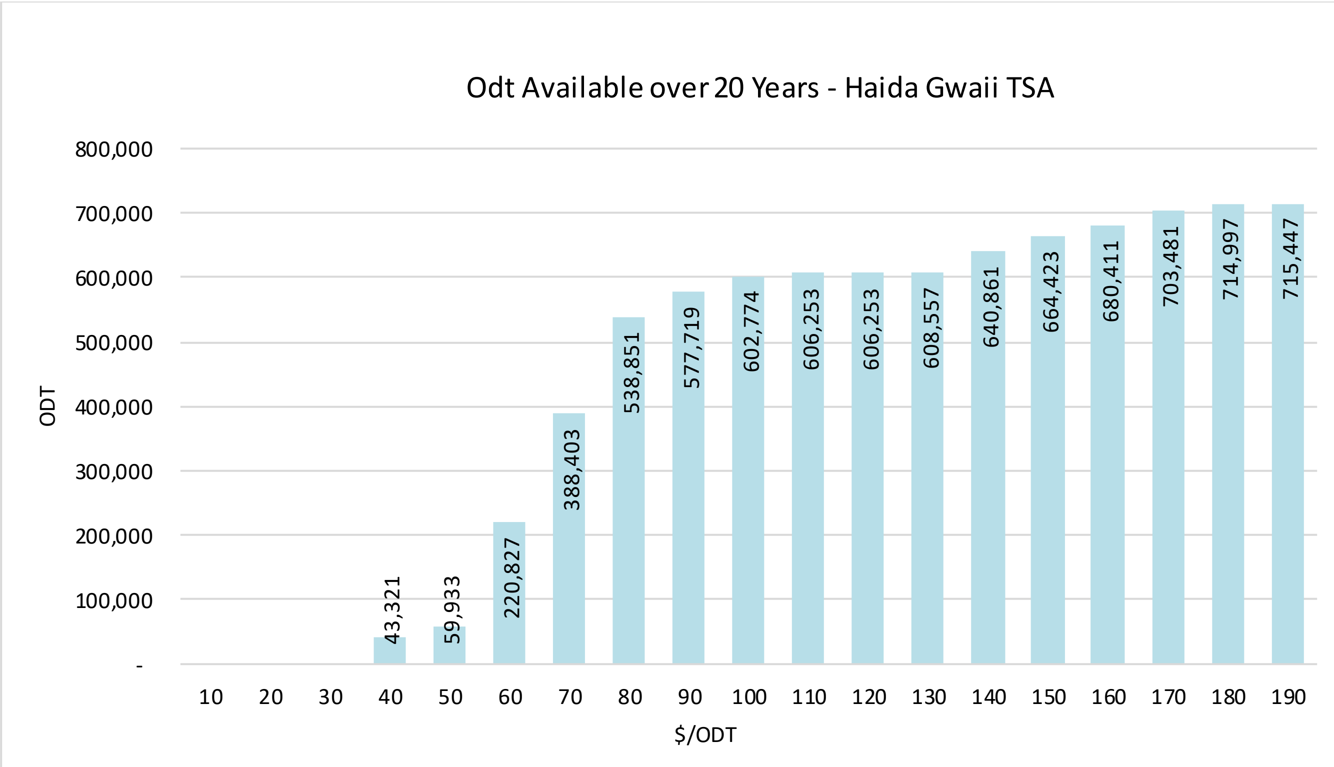

Figure 3. Haida Gwaii TSA biomass 'cost-availability' all periods.

4.5 Mapping

The distribution of costs by cutblock is shown in a heat map, as in Figures 4 below. The costs range up to $181/odt for the blocks farthest from the delivery points. The blocks are coloured in $15 colour increments as shown on the legend in Figure 4, with the dark green points being the ones with the lowest delivered biomass costs, and the dark red points being the most expensive, with a yellow transition in the middle. In this report, Figure 4 displays a doted purple line indicating the barge road going to Prince Rupert.

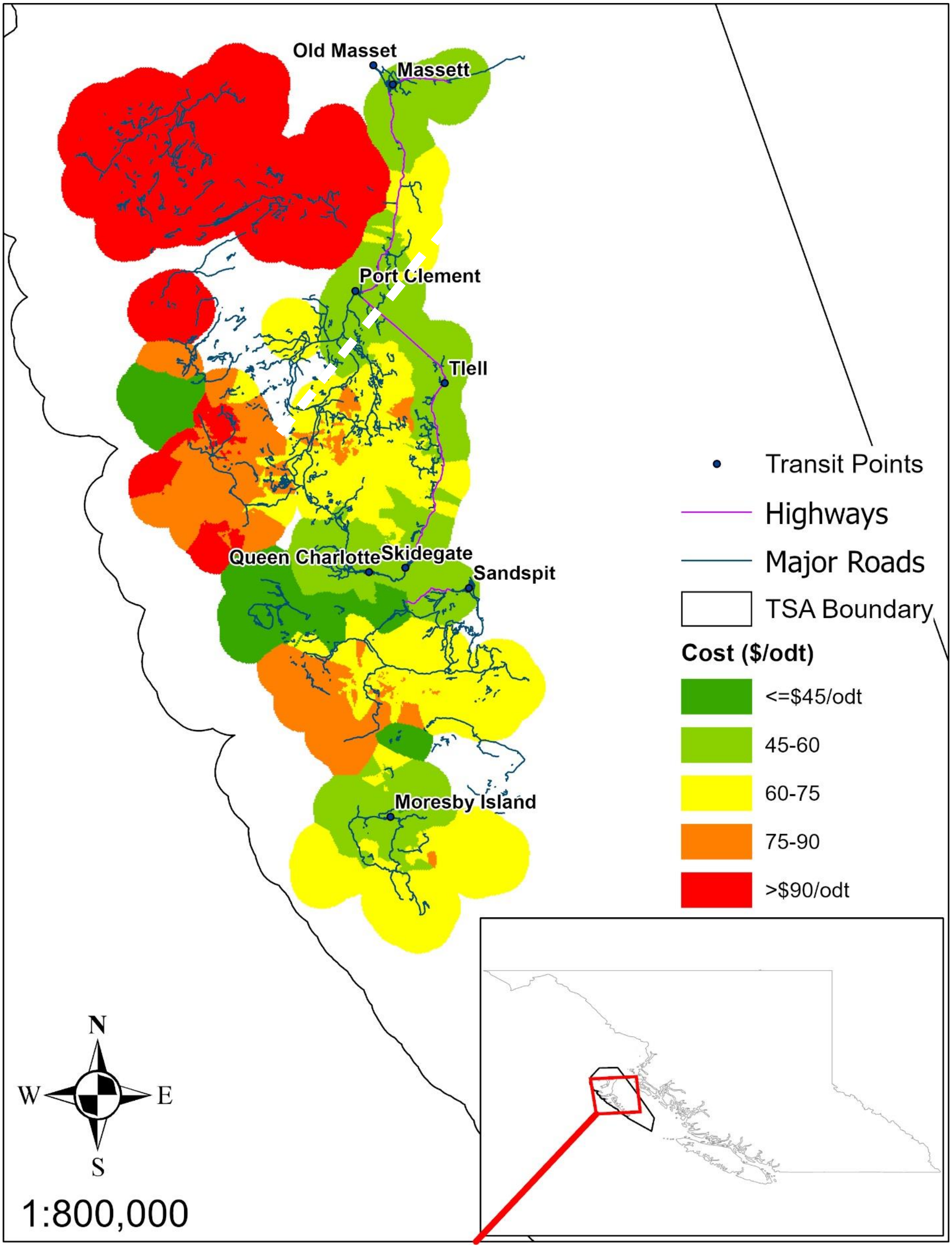

Figure 4. Spatial distribution of cutblocks by delivered biomass cost per odt.

The delivery points are represented by small green dots.

4.6 Temporal distribution of harvest

The harvest data contains a temporal period assigned to each cutblock. There are four periods in the data representing five-year periods. The first period covers the first five years of cutblocks, and the second period covers the second five years, etc. The dataset begins with year one as 2022.

The biomass yield per hectare remained relatively constant through the time periods and averaged 19.5 odt/ha. As shown in Figure 5, the amount of biomass available in periods 1 is consistently higher than any other period through the 20-year period, averaging 30% more biomass available. However, period 3 shows significantly less availability of biomass at the economic price points of $60/odt than the other periods. This means that more period 3 blocks are geographically farther from the delivery point than in the other periods.

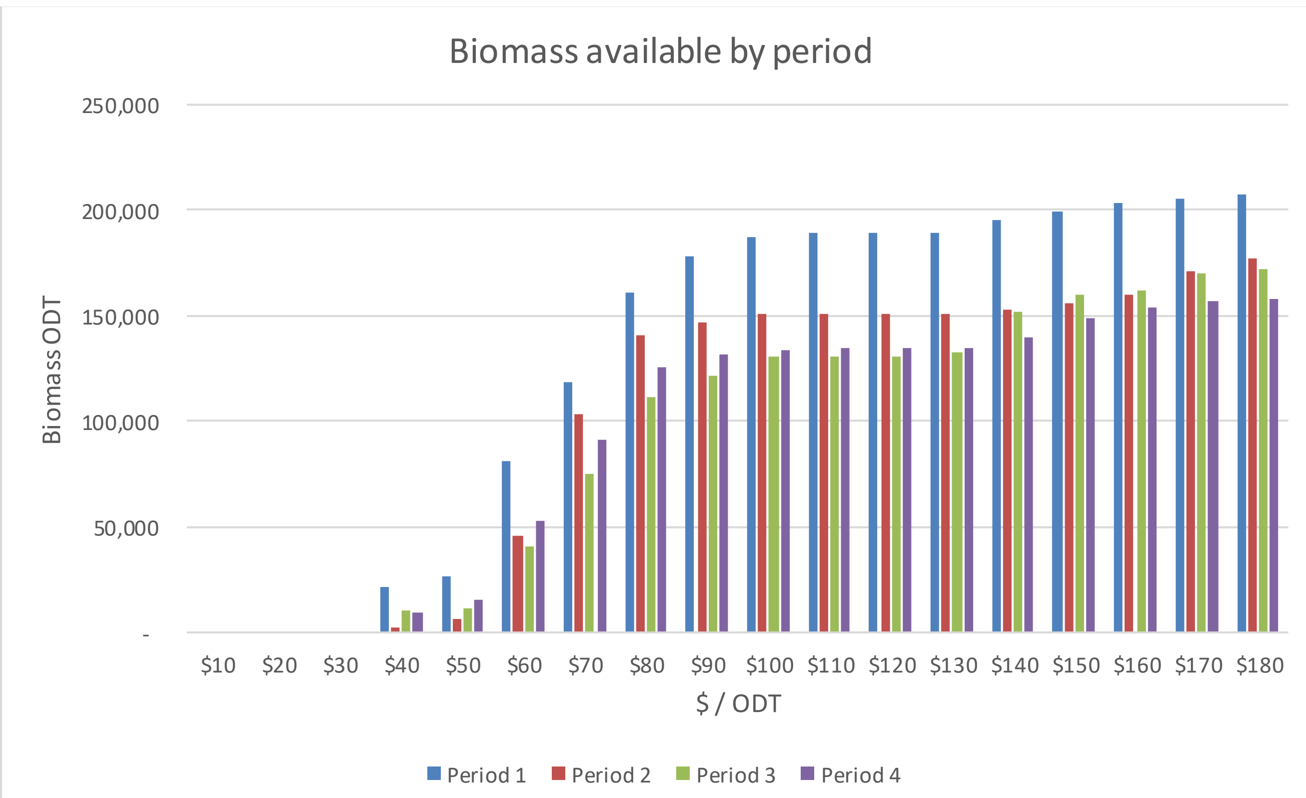

Figure 5. Biomass recoverable by period.

Table 7 shows the values used to create Figure 5 and includes the harvest area scheduled in each period. It also includes the biomass yield for each period.

Table 7. Availability by period

	Years 1-5	Years 6-10	Years 11-15	Years 16-20
Available biomass (odt)	455,287	390,297	379,154	347,672
Economic biomass (@ $60/odt)	81,441	45,822	40,956	52,608

Harvest area (ha)	11,208	8,828	9,037	7,710
Yield (odt/ha)	18.5	20.1	19.1	20.5
Biomass ratio (biomass/sawlog) (odt)	10.6%	10.8%	11.4%	12.1%

4.7 Results appendices

Appendices summarizing the different runs performed in FPInterface and showing the results of each run are included in Appendix 1.

5. CONCLUSION

The biomass yield per hectare predicted for the Haida Gwaii TSA is 19.5 oven-dried tonnes per hectare (odt/ha) from harvest residues. The biomass ratio, which is the ratio of recoverable biomass to recoverable merchantable roundwood, is estimated at 11.2%. Over the next 20 years a total of 1.5 million odt of available biomass could be generated by the harvesting 16.9 M of m^3 of roundwood in the Haida Gwaii TSA. The harvesting operations would generate approximately 75,000 odt/yr. Of the volume of biomass available, 14%, approximately 221,000 odt in total, or 11,000 odt/yr, is expected to be available at the economic price of $60 per oven-dried tonne. Delivery of biomass from the most expensive (distant) block is projected at $181/odt and the average delivered price for all biomass is $77.65/odt. The average transport distance from a cut block to a delivery point is 40 km.

Because the TSA is located on an island, economic availability of biomass (> $60/odt) is highly dependent on the logistics and transportation costs to the desired local delivery point. The biomass yield per hectare remained relatively constant through the time periods and averaged 19.5 odt/ha. As shown in Figure 5, the amount of biomass available in periods 1 is consistently higher than any other period through the 20-year period, averaging 30% more biomass available. However, period 3 shows significantly less availability of biomass at the economic price points of $60/odt than the other periods. This means that more period 3 blocks are geographically farther from the delivery point than in the other periods.