2601 East Mall
Vancouver, BC V6T 1Z4

www.fpinnovations.ca

Assessment of Forest Feedstock (Biomass) for Campbell River

by

A.J. MacDonald

Joanna Bernardo

Stuart Spencer

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This report was undertaken as part of the **Campbell River Regional Economic Investment Initiative**, a collaboration between the Ministry of Jobs, Tourism and Skills Training and the Campbell River Regional Economic Development Corporation (Rivercorp).

Disclaimer

This report is intended for readers who require detailed, technical information about biomass sources and volume within the Campbell River area, and the impact that changes in various operating conditions cause to biomass volumes and delivery costs.

Readers with less technical requirements can use the Executive Summary for the overall cost and volume information, and Appendix 5 for an overview of factors that differentiate biomass-recovery operations in coastal BC from other jurisdictions.

In addition to the information contained in this report, investors and industry proponents can access other information about the forest sector from the B.C. Ministry of Forests, Lands and Natural Resource Operations website at http://www.gov.bc.ca/for/, and may contact government offices of Fibre Connections BC , now found under the WoodSource BC umbrella at http://www.woodsourcebc.com.

Acknowledgements

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Executive Summary

Campbell River is the economic gateway to northern Vancouver Island. In January of 2012, Campbell River was selected as a pilot community for the Province's Regional Economic Investment Pilot, a key initiative of the BC Jobs Plan. The community was selected for its established focus on investment attraction, as well as its commitment to developing a vibrant local and regional business climate.

The Province partnered with the Campbell River Economic Development Corporation (Rivercorp) to identify key job creation and investment attraction projects that the initiative could advance, as the area undergoes significant economic transition.

On January 30, 2012, the Campbell River Economic Development Forum launched the initiative, which brought together community and business leaders to identify and prioritize key local economic development opportunities. Approximately 74 delegates were in attendance, from government, business, First Nations and academia.

A biomass inventory for Campbell River was identified at this forum as a priority project to help attract investment. Potential investors need to know the amount of biomass that is available in the Campbell River area and the cost of delivering the biomass to an industrial plant site.

In addition to basic costing information, FPInnovations was requested to answer the following six questions about forest-origin biomass near Campbell River:

1. How much timber is harvested and how much harvesting residue is produced annually by the major licensees in Campbell River area?
2. Where is the biomass located (e.g., road side, dispersed on cutover, sortyard) and what road access restrictions limit its recovery using current trucking technology?
3. Who are the tenure-holders where the biomass is located?
4. How far are the harvesting areas from Campbell River (by road and by water)?
5. Is the biomass old growth or second growth?
6. What is the biomass species distribution?

The analysis was based on the historic harvest levels for 23 supply areas near Campbell River, and includes roadside, dispersed, and sortyard residues. It assumed that roadside residues will be recovered using diesel-powered, mobile grinders in the cutblock to grind the residues and load the resulting hog fuel into semi-trailer chip vans for transportation. Dispersed residues include the avoidable waste component of waste survey from excessive stump height or other in-block processing, such as delimbing or bucking. The amount of residue is governed by the amount of conventional harvesting activities, a volume that can vary substantially from year to year. The study used 2011 harvest volumes to represent the average harvest volume.

In addition to physical characteristics that determine the total amount of biomass, the amount of recoverable biomass is determined by economic considerations. The report examined the effect of several of these adjustment factors. A key consideration is the price that a customer is willing or able to pay for the biomass, a value that depends on its end-use. Without knowing the proposed use of the biomass, FPInnovations estimated that $60 per oven dry tonne (ODt) was a reasonable maximum cost to use to calculate the net amount of available biomass. This corresponds to a maximum transportation cost of $36/ODt, after allowing $24/ODt for grinding and loading the biomass.

Applying the $36/ODt maximum transportation cost resulted in a **biomass volume of about 120,000 ODt/y** at an **average delivered cost of $46.71/ODt** from eight nearby road-accessible supply areas.

Selecting all 13 road-accessible supply areas (i.e., omitting all water-based supply areas) generated 155,000 ODt/y at an average cost of $52.55/ODt. See Table 5 and Table 7 for a list of the supply areas, their residue volumes, species distribution, transportation distances, and transportation costs.

Without considering the maximum transportation cost threshold, the total volume of biomass from all supply areas was 228,000 ODt/y at an average delivered cost of $56.93/ODt. Transportation costs from the various supply areas ranged from $22 - $ 82/ODt, which resulted in a delivered cost from $46 - $106/ODt. The avoidable waste portion of dispersed residues that could be harvested for an incremental yarding cost during primary logging was assumed to cost $5/ODt more than the roadside residues. However, this cost does not apply to harvesting any dispersed, non-merchantable fibre.

The total biomass volume was reduced or increased by about 50,000 ODt/y for the range of harvest volumes experienced between 2006 and 2010, with a corresponding change to the average delivered cost between $1.5 and $2.5/ODt. Improving the ability of chip vans to access the harvest sites on steep roads could increase the total amount of available biomass by 95,000 ODt/y. Accelerating the transition to more second growth harvesting could add about 10,000 ODt/y to the total amount of biomass. These preceding values presume that biomass would be recovered from all 23 supply areas, regardless of their distance and delivery cost to Campbell River.

Approximately 65% of the biomass was hemlock, 26% Douglas-fir, and 10% western cedar. Two-thirds of the biomass was from second-growth. Biomass would typically be produced in a mix of all species and ages, and any additional cost required to segregate the biomass by species or age was not considered in the analysis.

The report also discussed several items that differentiate coastal forest feedstock operations from biomass-recovery operations in the BC Interior:

- coastal feedstock has higher moisture content and can be contaminated with salt;
- the terrain is generally steeper;
- only about half of the surrounding area is accessible by road;
- much of the land is privately owned, and all residue recovery operations on private land must be done in cooperation with the private landowner; and
- fibre from private and public lands is covered by a series of agreements that limit the ability of the licensees or forest owners to enter into new biomass-focused ventures.

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I. Introduction

In 2009, FPInnovations produced an Assessment of Economically Accessible Biomass for Vancouver Island and the BC southern mainland as part of the BC Coastal Forest Sector Hem-Fir Initiative. It summarized the biomass from forest residues that was potentially available to six pulp mill sites on the south coast of BC. Although the biomass volume was dispersed across the study area, the report identified that Campbell River had the greatest concentration of biomass of the six sites, and therefore, had the greatest potential for industrial development.

The BC Ministry of Jobs, Tourism, and Skills Training (JTST) and the Campbell River Economic Development Corp (Rivercorp) held an investment forum in Campbell River during January 2012. Based on the high-level information contained in the 2009 assessment and other factors, the forum identified that biomass supplied to Campbell River from nearby harvesting operations may present a possible investment opportunity, but that the inventory information in the report was insufficient for their needs. JTST and Rivercorp began discussions with FPInnovations to provide additional information for potential biomass investors at Campbell River.

In addition to basic costing information, FPInnovations was requested to answer the following six questions about forest-origin biomass near Campbell River:

1. How much timber is harvested and how much harvesting residue is produced annually by the major licensees in Campbell River area?
2. Where is the biomass located (e.g., road side, dispersed on cutover, sortyard) and what road access restrictions limit its recovery using current trucking technology?
3. Who are the tenure-holders where the biomass is located?
4. How far are the harvesting areas from Campbell River (by road and by water)?
5. Is the biomass old growth or second growth?
6. What is the biomass species distribution?

This biomass assessment is a more detailed analysis of the biomass availability near Campbell River, and is intended to answer the six questions using the same basic analytic procedures as was used in the 2009 assessment.

II. Biomass description

In this assessment, biomass is considered from three sources: roadside harvesting residues, dispersed residues, and dryland sort residues.

Roadside harvesting residues

Roadside residues are generated by delimbing, bucking, or roadside processing, and have traditionally been piled on the roadside and burned after harvesting operations are completed. These roadside residues represent the bulk of accessible harvest residues.

Second growth residues consist mainly of tops, branches, and long butts. The maximum diameter of tree tops depends on the utilization standard, but is usually about 12-18 cm diameter, and their length is 6-8 m. Diameter of long butts depends on the size of the trees, but is usually about 40-70 cm, and their length is about 100-200 cm. Current second-growth operations are frequently in stands dominated by a single species, usually Douglas-fir or western hemlock. Old growth roadside residues generally contain larger-diameter pieces, and may also contain multiple species in an unsorted mixture. Shattered or broken pieces are more common in old-growth residues than in second-growth. The size and volume of the roadside residues can vary significantly depending on the utilization standard for merchantable logs that is in effect.

This study considered only one method for recovering roadside residues, i.e., to grind them into hog fuel using a diesel-powered, mobile, horizontal grinder that loads the hog fuel into semi-trailer chip vans for transportation to the destination. Large equipment is required to handle the size of residues that is typically found in coastal harvesting operations.

The annual volume of roadside residues was calculated by multiplying the annual harvest volumes by the biomass ratios for various harvesting systems, timber types, and species. Biomass ratios are calculated by dividing the tonnes of biomass that can be recovered into a chip van by the tonnes of merchantable logs that generated the biomass. The biomass ratio can also be calculated using cubic metres instead of tonnes. The best method to calculate or confirm biomass ratios is to conduct a grinding operation and to measure its inputs and outputs, however, few such studies have been undertaken on coastal BC. As an alternative, the 2009 assessment measured the dimensions of a sample of roadside residue piles, and then calculated their volumes and their biomass ratios using a pile-volume density factor and the reported harvest volumes from the cutblocks. Biomass ratios were produced for Douglas-fir, hemlock, and cedar forest types in old-growth and second-growth for harvesting systems in which manufactured logs or full-length trees were extracted to roadside. For the purposes of this study, both ground-based and cable systems were combined into a single class as distinguished from aerial (helicopter) systems. The values from the 2009 assessment were reviewed and updated in consideration of grinding trials that FPInnovations conducted since 2009. One completed and one partially completed coastal grinding trial indicated that the previous estimates for biomass ratios were too low except for second-growth fir. The biomass ratios used for the base case are shown in Table 1, while a range of biomass ratios for low, medium, and high estimates are shown in Appendix 1.

Stand attributes and log-handling methods		Biomass ratio (%)			
		Ground and cable harvesting		Aerial harvesting	
		Logs to roadside	Trees to roadside	Logs to roadside	Trees to roadside
Hemlock	Old growth	13	15	2	2
	Second growth	10	15	2	2
Cedar	Old growth	8	10	2	2
	Second growth	9	15	2	2
Fir	Old growth	10	12	2	2
	Second growth	9	15	2	2

Table 1 Biomass ratios used for base case of roadside residue volume calculation.

Dispersed residue

Dispersed residues are residues that are generated on the cutover and not extracted to roadside. The 2009 assessment used the BC Ministry of Forests waste assessments as a surrogate for dispersed residues, while recognizing that the waste assessment comprises avoidable and unavoidable waste. Only the avoidable waste component from excessive stump height or other in-block processing, such as delimbing or bucking was considered as a potential source for biomass recovery. Breakage during felling and yarding can also result in significant amounts of dispersed residue, however, breakage was not included in the volume calculation for either the 2009 assessment or this study.

The average volume per hectare of avoidable waste in old growth and second growth classes was calculated for three utilization specification levels.

Table 2 shows the values for the Campbell River district as used for this assessment. The current values were calculated in the 2009 assessment from annual waste assessment surveys produced by the BC Ministry of Forests. The low and high values were estimated by FPInnovations. The stand volumes were used to calculate the harvested hectares from the harvested volumes in order to calculate the amount of dispersed residues.

Utilization Specification	Dispersed residue from avoidable waste (ODT/ha)		Stand volume (m^3/ha)	
	Old growth	Second growth	Old growth	Second growth
Low	15	5	645	450
Medium	25	15	645	450
High	30	20	645	450

Table 2 Amount of dispersed residue per hectare used for sensitivity analysis.

Dryland sort residue

The volume of sortyard residue compared to logged volume is not well documented, with estimates ranging from 1.5%[1], 4-6% (Sinclair 1981), and 10% (Forrester 1996). FPInnovations used a value of 3%, and calculated the biomass volume generated at sortyards by multiplying the total volume by this amount. Sortyard residues often contain high levels of moisture and small pieces ("fines"), and may be mixed with soil, rocks, or other contaminants, which reduces their quality as feedstock. Cleaning the residues prior to grinding may be required. Multiple species are likely to be mixed.

III. Supply area description

Twenty three supply areas based on tenure boundaries and established road systems were identified in the Campbell River biomass collection area, sixteen within the Campbell River forest district and seven from North Island – Central Coast forest district. Their general locations are shown schematically in Figure 1; their harvest volumes were calculated independent of the symbolic map boundaries. The harvest volumes supplied to FPInnovations by the licensees during the 2009 assessment were reviewed with the licensees for this assessment, and then further compared with summaries from the BC Harvest Billing System (HBS). Harvest volumes from 2010, 2011, and 2006 were selected from HBS to represent low, medium, and high total harvest volumes respectively as shown in Table 3. Contact information for the licensees is shown in Appendix 2.

HBS uses fewer reporting areas than the 23 supply areas used in this analysis, and could not be used directly. Further, not all supply areas were reported in all HBS summaries. Therefore, FPInnovations divided the reported HBS harvest volumes among the various supply areas that comprise each reported volume. The total harvest volume from all supply areas equals the total HBS volume, and the harvest volume for each tenure unit such as a

[1] Doug Meske, Western Forest Products, Inc. Personal communication, July 2008

tree farm licence or forest district matches the total volume reported in HBS. The medium harvest volumes for the private lands were supplied by the landowners as indicative of long-term average harvest volumes. The harvest volumes for individual supply areas can vary in unusual patterns such as having a high harvest volume in 2010 when the overall harvest level was lowest. FPInnovations did not attempt to determine the cause of these anomalies, but it is worth noting that the harvest volumes from specific supply areas can vary substantially from year to year. This behaviour was likely caused by consolidating the harvest in particular supply areas during the recent economic downturn or for operational reasons such as addressing major windfall events.

The 2011 harvest volume (medium level, 5.15 M m^3) was used for the base case analysis. This volume compares with 5.36 M m^3 of total harvest volume for the 23 supply areas that was used in the 2009 assessment.

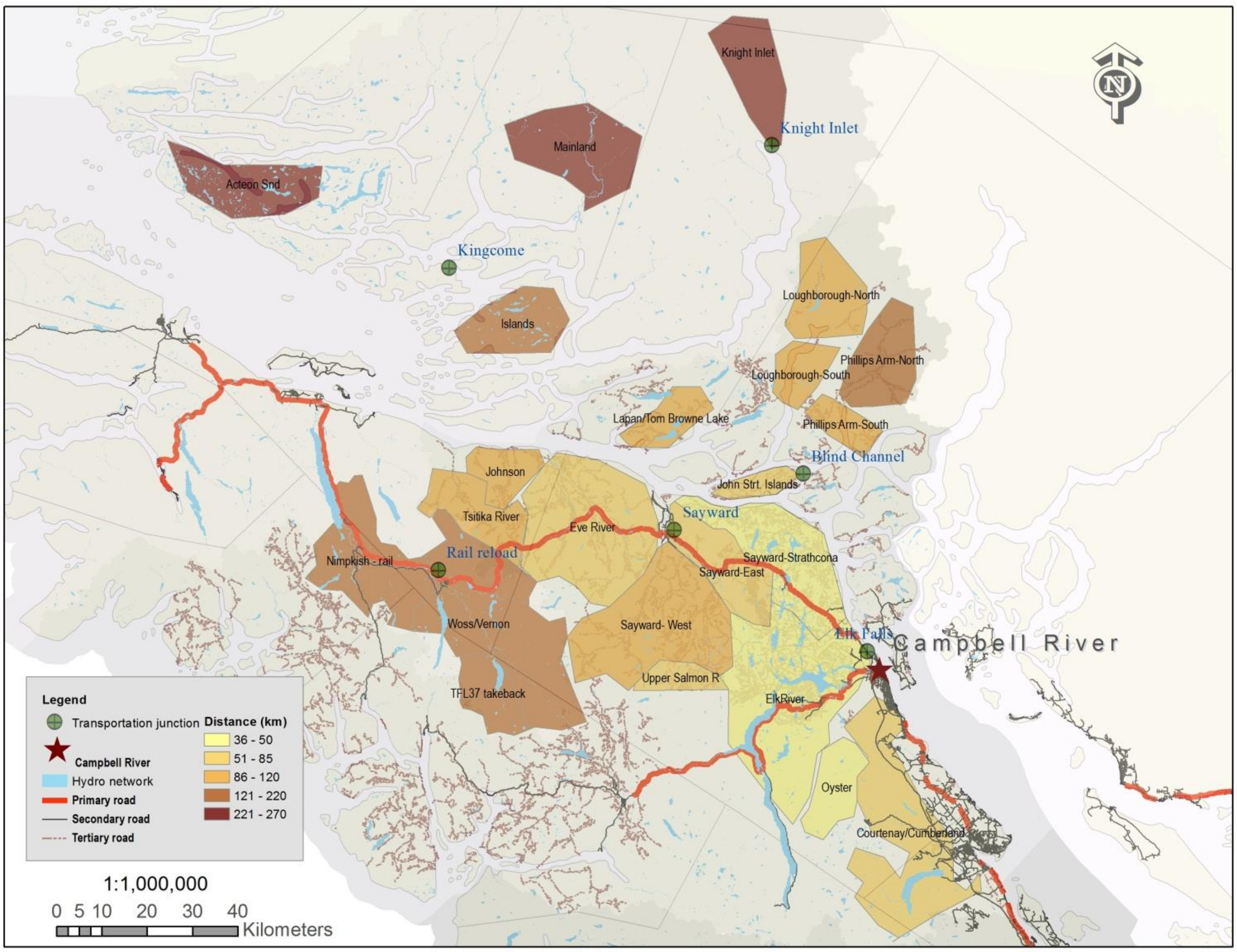

Figure 1 Biomass supply areas and distance map near Campbell River

	HBS Harvested Volumes (m^3)			
Supply Area Name	2010 (Low)	2011 (Medium)	2006 (High)	Used in 2009 assessment[2]
Nimpkish - rail	285,995	299,936	268,342	226,173
Woss/Vernon	567,452	595,113	532,426	448,757
Johnson	80,311	98,665	139,333	117,736
Eve River	219,670	400,721	323,303	350,000
Tsitika River	189,953	233,362	329,551	278,470
Sayward-West	219,670	400,721	323,303	350,000
Sayward-East	62,763	114,492	92,372	100,000
Sayward-Strathcona	238,745	293,306	414,202	350,000
Elk River	158,993	270,000	497,384	643,662
Courtenay/Cumberland	123,710	180,000	387,005	500,821
Oyster	120,000	140,000	362,464	260,000
Upper Salmon River	6,821	8,380	11,834	10,000
Knight Inlet	34,153	11,263	94,799	130,000
Loughborough-North	63,162	152,550	85,431	229,293
Phillips Arm-North	183,014	333,852	269,353	291,595
Phillips Arm-South	11,117	54,749	64,346	65,000
Lapan/Tom Browne Lake	412,169	483,107	468,159	160,357
Johnson Strait Islands	212,054	248,551	240,860	82,501
Islands	182,657	175,143	295,799	150,000
Mainland	182,657	175,143	295,799	150,000
Acteon Sound	304,428	291,905	492,999	250,000
Loughborough-South	136,426	167,603	236,687	200,000
TFL37 takeback	13,643	16,760	23,669	20,000
Totals	4,009,563	5,145,322	6,249,419	5,364,365

Table 3 HBS harvest volumes used for low, medium, and high harvest levels in the Campbell River biomass supply areas.

Table 4 shows additional attributes for the supply areas that affect the volume and cost of biomass recovery. The percentage of old growth and second growth was based on licensees' previous assessment of harvest age distribution. Second growth is generally considered to be stands less than 100 years old.

[2] Estimated harvest volume as reported by tenure holder for the 2009 assessment

Supply area name	Licensee	Old Growth (%)	Second Growth (%)	Distance to Campbell River (km)	Water transport	OG Chip-van Access (%)	SG Chip-van Access (%)
Nimpkish - rail	WFP	72%	28%	151.3	No	30%	50%
Woss/Vernon	WFP	88%	12%	135.5	No	30%	50%
Johnson	BC	65%	35%	111.0	No	40%	70%
Eve River	WFP	91%	9%	83.5	No	40%	70%
Tsitika River	BC	65%	35%	111.4	No	40%	70%
Sayward-West	WFP	91%	9%	88.7	No	40%	70%
Sayward-East	WFP	91%	9%	70.0	No	40%	70%
Sayward-Strathcona	BC	9%	91%	41.7	No	40%	70%
Elk River	TWFC	7%	93%	36.4	No	80%	80%
Courtenay/Cumberland	TWFC	7%	93%	64.2	No	20%	40%
Oyster	ITL	93%	7%	36.4	No	50%	70%
Upper Salmon River	BC	100%	0%	55.0	No	50%	50%
Knight Inlet	Interfor	90%	10%	262.6	Yes	20%	80%
Loughborough-North	WFP	60%	40%	119.1	Yes	20%	40%
Phillips Arm-North	WFP	90%	10%	128.9	Yes	20%	40%
Phillips Arm-South	Interfor	50%	50%	91.2	Yes	20%	80%
Lapan/Tom Browne Lake	TWFC	5%	95%	105.1	Yes	20%	80%
Johnson Strait Islands	TWFC	0%	100%	71.4	Yes	20%	80%
Islands	BC	40%	60%	211.0	Yes	20%	40%
Mainland	BC	50%	50%	245.9	Yes	5%	20%
Acteon Sound	BC	90%	10%	244.5	Yes	5%	20%
Loughborough-South	BC	50%	50%	92.0	Yes	20%	40%
TFL37 takeback	BC	88%	12%	149.4	No	20%	40%

Table 4 Additional supply area attributes.

The average haul distance for old growth and second growth was estimated to a common point for each supply area, and added to the truck or water-based transport distance to Campbell River. The base case assessment assumed that roadside residues from Nimpkish rail, Johnson, Tsitika, and TFL37 takeback supply areas would be hauled by truck to Campbell River even though logs from those areas are normally hauled to other destinations. The distances shown in Table 4 for supply areas that require water transport include the distance that the biomass is transported by barge.

For the 2009 assessment, the licensees provided estimates of the amount of old-growth and second-growth harvesting volume for each supply area that was on roads accessible by chip vans. These values were reviewed and adjusted by FPInnovations based on a survey of chip-van accessibility on the east coast of Vancouver Island conducted by FPInnovations in 2010. This is explained in further detail in the sensitivity analysis.

The 2009 assessment excluded all supply areas that require water transportation, however, the base case for the current assessment includes such areas under the assumption that the residues will be ground and loaded onto barges for transportation to Campbell River.

IV. Base case volume and cost calculation

The base case volume of roadside residue was calculated by species for each supply area using the species distribution, the proportion of old growth and second growth harvest volume, and the proportion of ground- and aerial-based harvesting as reported by the licensees for the 2009 assessment. The residue volumes in Table 5 were derived using the 2011 volumes from Table 3 and the chip-van accessibility from Table 4.

	Annual Roadside Residue Production (ODt/y)						
	Old Growth			Second Growth			Total
Supply Area Name	Cedar	Fir	Hemlock	Cedar	Fir	Hemlock	
Nimpkish - rail	388	415	2,061	54	432	1,140	4,490
Woss/Vernon	1,278	444	4,583	214	536	595	7,650
Johnson	272	82	827	279	-	739	2,199
Eve River	949	59	5,341	-	640	539	7,527
Tsitika River	642	194	1,957	660	-	1,748	5,201
Sayward-West	949	59	5,341	-	640	539	7,527
Sayward-East	271	17	1,526	-	183	154	2,151
Sayward-Strathcona	73	137	236	113	3,967	6,324	10,849
Elk River	-	180	566	308	7,711	1,581	10,346
Courtenay/Cumberland	-	30	94	103	2,570	527	3,325
Oyster	116	537	2,473	-	282	114	3,522
Upper Salmon River	39	16	124	-	-	-	179
Knight Inlet	14	3	51	-	-	35	103
Loughborough-North	151	46	404	113	113	740	1,566
Phillips Arm-North	414	100	1,514	-	-	518	2,547
Phillips Arm-South	35	21	194	81	81	708	1,120
Lapan/Tom Browne Lake	31	-	196	1,063	4,251	14,988	20,528
John Strait Islands	-	-	-	547	3,828	6,609	10,984
Islands	185	-	283	504	-	1,576	2,549
Mainland	35	-	124	168	-	701	1,027
Acteon Sound	270	-	118	-	-	292	680
Loughborough-South	78	141	295	176	527	1,062	2,278
TFL37 takeback	24	8	86	5	12	13	149
Sum	6,214	2,489	28,394	4,388	25,773	41,292	108,497
Sum by age class	37,095			71,400			
Sum by species	10,602	28,261	69,633				

Table 5 Annual roadside residue production by supply area and species.

Table 6 shows the parameters used to calculate haul cost, as were developed in the 2009 assessment. Truck payloads are representative of semi-trailer chip vans.

Haul Cost Parameter	
Payload (ODt)	14
Loading rate (ODt/h)	25
Loading time (h)	0.56
Unloading time (h)	0.3
Delay time per cycle (h)	0.2
Cycle fixed time (h)	1.06
Truck cost ($/h)	110
Average travel speed within supply area (km/h)	40
Fixed haul cost ($/ODt)	8.33
Variable haul cost ($/ODt-km)	0.39
Variable haul cost – mainline ($/ODt-km)	0.26
Variable haul cost – highway ($/ODt-km)	0.18
Fixed barging costs ($/ODt)	15.22
Variable barging costs ($/ODt-km)	0.10

Table 6 Haul cost parameters.

Table 7 summarizes the total amount of roadside and dispersed biomass residues from each supply area, plus the transportation cost to Campbell River. Supply areas are shown in order of increasing transportation costs. Transportation costs for water-based supply areas include the barging cost.

Supply Area Name	Roadside (ODt)	Dispersed (ODt)	Total (ODt)	Road Distance (km)	Water Distance (km)	Transportation ($/Odt)
Elk River	10,346	7,282	17,628	36.4	0.0	$21.99
Oyster	3,522	2,752	6,274	36.4	0.0	$22.02
Sayward-Strathcona	10,849	6,637	17,486	41.7	0.0	$24.08
Sayward-East	2,151	1,856	4,007	70.0	0.0	$25.61
UpperSalmon River	179	162	341	55.0	0.0	$29.24
Eve River	7,527	6,495	14,022	83.5	0.0	$30.88
Sayward-West	7,527	6,495	14,022	88.7	0.0	$32.89
Courtenay/Cumberland	3,325	2,330	5,655	64.2	0.0	$35.40
Loughborough-South	2,278	1,767	4,045	10.0	82.0	$36.06
PhillipsArm-South	1,120	942	2,062	12.2	80.0	$36.62
Lapan/TomBrowneLake	20,528	12,426	32,954	11.1	60.0	$37.70
John Strait.Islands	10,984	6,628	17,612	11.4	60.0	$38.92
Woss/Vernon	7,650	6,467	14,117	135.5	0.0	$39.06
Loughborough-North	1,566	1,523	3,089	18.1	41.0	$41.12
Johnson	2,199	1,800	3,999	111.0	0.0	$41.59
Tsitika River	5,201	4,258	9,459	111.4	0.0	$41.75
Phillips Arm-North	2,547	2,774	5,321	27.9	101.0	$44.93
TFL37 takeback	149	126	275	149.4	0.0	$46.11
Islands	2,549	1,880	4,429	18.0	198.0	$50.28
Acteon Sound	680	636	1,316	21.5	223.0	$54.64
Mainland	1,027	734	1,761	31.0	35.0	$57.53
Nimpkish-rail	4,490	3,581	8,071	151.3	0.0	$65.82
Knight Inlet	103	98	201	32.6	230.0	$81.67
Sum	108,497	79,650	188,147			
Weighted average transport cost						$35.67

Table 7 Roadside and dispersed residue volumes plus transport and cost.

Four sortyards in the Campbell River area were identified, and the annual log production in each sortyard was validated with tenure holder or is the operator's reported production. Additional volume that does not currently flow through these four sortyards, but is from supply areas that could generate sortyard residues was tallied and added to a miscellaneous sortyard. FPInnovations assumed that the residues were equal to 3% of log production, and that volume-to-weight conversion factor was 0.4 ODt/m^3 (Table 8).

Site name	Annual log production (m^3/y)	DLS residue (ODT/y)
Sayward Timber	500,000	6,000
Timberwest (North Island Log Sort)	600,000	7,200
Menzies Bay	882,643	10,592
Sayward- Kelsey Bay	1,124,537	13,494
Miscellaneous	226,196	2,714
Total	3,333,376	40,000

Table 8 Annual log production and estimated residue from each DLS.

The total cost for recovering the roadside residues includes the transportation cost plus a processing cost. FPInnovations used $24.02/ODt to collect, grind, and load the roadside residue biomass in all supply areas. This cost was developed in the 2009 assessment for a horizontal grinder and hydraulic loader operating at roadside to grind the residues after harvesting is completed (Table 9). Hauling residues to an intermediate site, using different truck configurations to match road conditions, or other site-specific considerations that could affect the recovery cost would need to be considered in any operational planning.

Comminution cost parameter	
Grinder cost ($/SMH)	210.77
Loader cost ($/SMH)	128.59
Combined cost ($/SMH)	339.36
Profit and risk allowance	15%
All-found cost ($/SMH)	390.26
Utilization	65%
All-found system cost ($/PMH)	600.41
Productivity (ODt/PMH)	25
Cost ($/ODt)	24.02
Mobilization ($/ODt)	1.50-6.00

Table 9 Comminution costs.

The 2009 assessment discussed how the cost of delivering the dispersed residues could vary depending on how it is handled. The report concluded that the cost of delivering the additional volume was expected to increase, but that additional research was required to determine the amount. No additional research has been done in this area since the 2009 assessment, therefore FPInnovations estimated the cost for the dispersed volume was $5/ODt more than the cost for processing and delivering roadside residues. It must be emphasized that dispersed residues include only the avoidable wastes that could be harvested for an incremental yarding cost during primary logging and does not include harvesting any non-merchantable fibre. The recovery cost was estimated from an incremental cost to account for additional yarding time ($0.15/m^3 applied to all harvested volume), 450 m^3/ha of merchantable logs, and 15 ODt/ha of dispersed residue.

Cost for comminuting and delivering the sortyard residues was assumed to be $34/ODt, regardless of the sortyard location, based on $24/ODt for comminution cost plus $10/ODt for delivery.

Using the 2011 harvest volume from HBS, roadside and dispersed residues from all the supply areas including the water-only supply areas, and residues from all sortyards, FPInnovations calculated there were 228,147 ODt of residues produced annually in the Campbell River area (Table 10). The average delivered cost of the residues was $56.93/ODt. Again it must be emphasized that the dispersed residues represent only the avoidable waste portion that could be harvested at minimal extra cost.

Biomass source	Volume (ODt)	Average Delivered Cost ($/ODt)
Roadside residues	108,497	$59.69
Dispersed residues	79,650	$64.69
Sortyard residues	40,000	$34.00
Total	228,147	$56.93

Table 10 Volume and cost for all residue sources.

The average cost is derived from all supply areas regardless of their individual costs, and is intended only to show the total amount and its overall cost. The total amount may not be practical to recover because the delivery cost from some supply areas would be higher than the value of their biomass, and the areas would not be considered seriously for recovery. One of the sensitivity analyses in the following section shows how the recoverable volume varies with different transportation cost thresholds.

V. Sensitivity analysis

A sensitivity analysis was conducted to examine the effect of various parameters on the cost and volume of delivered biomass. Each of the following parameters was varied around the base case scenario.

1. Harvest volume: used HBS volumes from 2010 and 2006
2. Transition rate to second growth: increased the proportion of second-growth harvest volume over the levels used in the 2009 assessment.
3. Accessibility by chip vans: used lower and higher percentage of chip van accessibility
4. Biomass ratio and dispersed residues: used lower and higher estimates of the biomass ratios and amount of dispersed residues
5. Transportation cost threshold: set low and high thresholds on transportation cost
6. No water transportation: omitted supply areas that require water transportation
7. Dryland sort residue percentage: used lower and higher estimates of sortyard residue production

Harvest volume: The base case scenario used the HBS harvest volume for 2011, while the volumes from 2010 and 2006 were used as low and high harvest volumes respectively. Sortyard volumes were varied in proportion to the harvest volume. The delivery cost and total biomass for the three harvest levels are summarized in Table 11. The harvest volume for each supply area was shown in Table 3. The trend of reducing cost with increasing volume was caused by the proportion of volume from sortyard residues and the distribution of harvest among the supply areas as reported by HBS. There was no adjustment to the costing model to account for increased capacity utilization.

Harvest Rate	Harvest volume (m^3/y)	Roadside residue (ODt/y)	Transportation cost ($/ODt)	Dispersed residue (ODt/y)	DLS residue (ODt/y)	Total biomass (ODt/y)	Average delivered cost ($/ODt)
Low	4,009,563	83,287	$36.79	60,261	31,171	179,635	$57.41
Base	5,145,322	108,497	$35.67	79,650	40,000	228,147	$56.93
High	6,249,419	132,362	$34.49	96,325	48,583	277,270	$54.50

Table 11 Net volume and delivery cost by different harvest levels

Transition to second growth

The base case used the distribution between old-growth and second-growth harvesting as supplied by the licensees for the 2009 assessment, even though the proportion of second growth is known to increase over time. FPInnovations estimated the increase in the second-growth volume for each supply area on gradual or accelerated schedules based on each supply area's current second-growth harvest proportion and its location relative to advanced second-growth stands (Appendix 3). Second growth currently comprises about 60% of the harvested volume for all supply areas used in the analysis. FPInnovations estimates this proportion will increase to about 65% based on the gradual transition schedule, and about 70% on the accelerated schedule.

The species distributions and the harvesting system (i.e., ground and aerial systems, and trees or logs to roadside) were kept constant and the same biomass ratios were used as for the base case. The transition to more second growth generated about 10,000 ODt/y more on the accelerated transition than is currently produced (Table 12).

Transition Rate to Second Growth	Roadside residue (ODt/y)	Transportation cost ($/ODt)	Dispersed residue (ODt/y)	Roadside and dispersed (ODt/y)	Average delivered cost ($/ODt)
Current	108,497	$35.67	79,650	188,147	$56.93
Gradual	111,033	$36.68	81,181	192,214	$57.02
Accelerated	114,690	$35.72	83,376	198,066	$57.17

Table 12 Roadside and dispersed residue at different transition rates to second growth.

Accessibility by chip vans

A field survey of 36 cutblocks conducted by FPInnovations in 2010, mainly in second-growth stands on the east coast of Vancouver Island between Nanaimo and Campbell River, concluded that 60% of valley bottom roads, 42% of mid-slope roads, and 45% of ridgetop roads were accessible using current semi-trailer truck configurations. It also estimated that 60% of the areas suitable for ground-based harvest systems and 30% of the areas suitable for cable harvest systems were accessible by chip vans. Accessibility was restricted mainly by steep grades on spurs, branch roads, and mainlines, tight switchbacks, and steep sideslopes that prevent grinders from working at roadside.

The survey was generally confined to sites that avoided the steepest ground, yet the accessibility values were lower than the estimates provided by the licensees for the 2009 assessment. Accordingly, the chip-van accessibility values for each supply area was reviewed and adjusted for this new assessment. The chip van accessibility levels were subsequently adjusted up or down for the sensitivity analysis (Appendix 4) and summarized in Table 13.

Chip van accessibility	Roadside residue biomass (ODt/y)	Transportation cost ($/ODt)	Dispersed residue (ODt/y)	Roadside and dispersed (ODt/y)	Average delivered cost ($/ODt)
Low	78,494	$34.68	57,059	135,553	$54.70
Base	108,497	$35.67	79,650	188,147	$56.93
High	159,985	$36.42	122,867	282,852	$59.07

Table 13 Roadside residues available for three levels of chip van accessibility.

Biomass ratio and dispersed residues

The amount of roadside residue is determined in these calculations by the biomass ratio, which is the proportion of biomass that can be recovered and loaded onto a truck compared to the volume of merchantable logs required to produce the biomass. There are two sources of uncertainty about what biomass ratio to use:
1) Merchantable utilization specifications can change from time to time, which affects the biomass ratio and 2) the number of field measurements to validate the estimates is low. The sensitivity analysis used three estimates of the biomass ratio (Appendix 1) and the values for dispersed residues from Table 2 based on FPInnovations' best current knowledge.

Table 14 shows that the amount of roadside residue will shrink or grow by about 30,000 ODt per year for the low and high values for biomass ratio. Likewise, it could grow by 21,000 or shrink by 43,000 ODt per year for changes in the dispersed residues. The cost for recovering the roadside and dispersed residue does not vary substantially, but the average cost varies because of the varying proportions of the different biomass sources.

Biomass ratio and dispersed residue level	Roadside residue (ODt/y)	Transportation cost ($/ODt)	Dispersed residue (ODt/y)	Roadside and dispersed (ODt/y)	Average delivered cost ($/ODt)
Low	78,398	$35.83	33,487	112,885	$54.18
Base	108,497	$35.67	79,650	188,147	$56.93
High	145,514	$35.64	102,402	233,846	$58.04

Table 14 Amount and cost of roadside and dispersed residues for three levels of biomass ratio.

Transportation cost threshold

Without knowing what technology will use the biomass, it is difficult to know the appropriate maximum cost to use. Therefore FPInnovations used two transportation cost thresholds that were selected to omit particular supply areas from the analysis. A $42/ODt maximum transportation cost (Table 7) mainly omits the supply areas that require water transportation, while a $36/ODt maximum cost also omits the supply areas from the Nimpkish Valley region. These threshold values correspond to delivered costs of $64 and $60/ODt respectively.

Table 15 shows that specifying a maximum $36/ODt transportation cost will reduce the roadside volume to about 45,000 ODt/y and reduce the average transportation cost to $26.95/ODt. If the sortyard residues (40,000 ODt/y) are unaffected when transportation cost is capped at $36/ODt, the total amount of biomass is about 120,000 ODt/y and the average delivered cost is $46.71. Note that sortyard residues comprise nearly 35% of the total at this production level compared to 17% in the base case.

Maximum transportation cost from each supply area ($/ODt)	Number of supply areas selected	Roadside residue biomass (ODt/y)	Average transportation cost ($/ODt)	Dispersed residue biomass (ODt/y)	Roadside and dispersed residue (ODt/y)	Average delivered cost ($/ODt)
Unlimited (90)	23	108,497	$35.67	79,650	188,147	$56.93
42	16	96,952	$33.22	69,820	166,772	$54.43
36	8	45,426	$26.95	34,009	79,435	$46.71

Table 15 Roadside residues available for three values of maximum transportation cost.

Another method to illustrate the impact of transportation cost is to show the amount of roadside biomass as a function of the delivered cost from each supply area (Figure 2). The amount and average delivered cost of roadside, dispersed, and sortyard are shown in Figure 3.

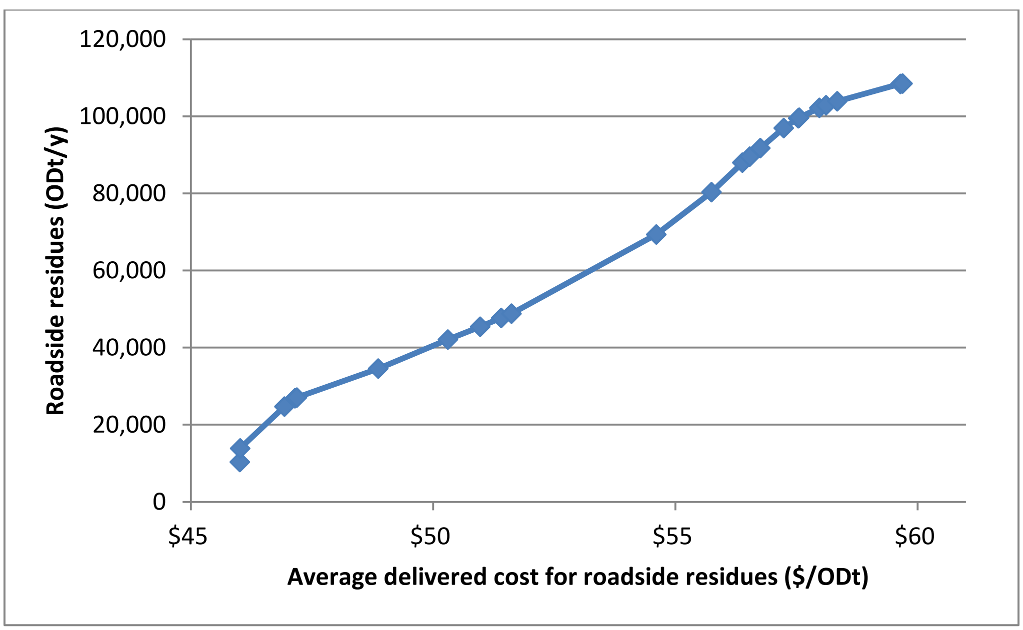

Figure 2 Volume of roadside residues versus delivered cost.

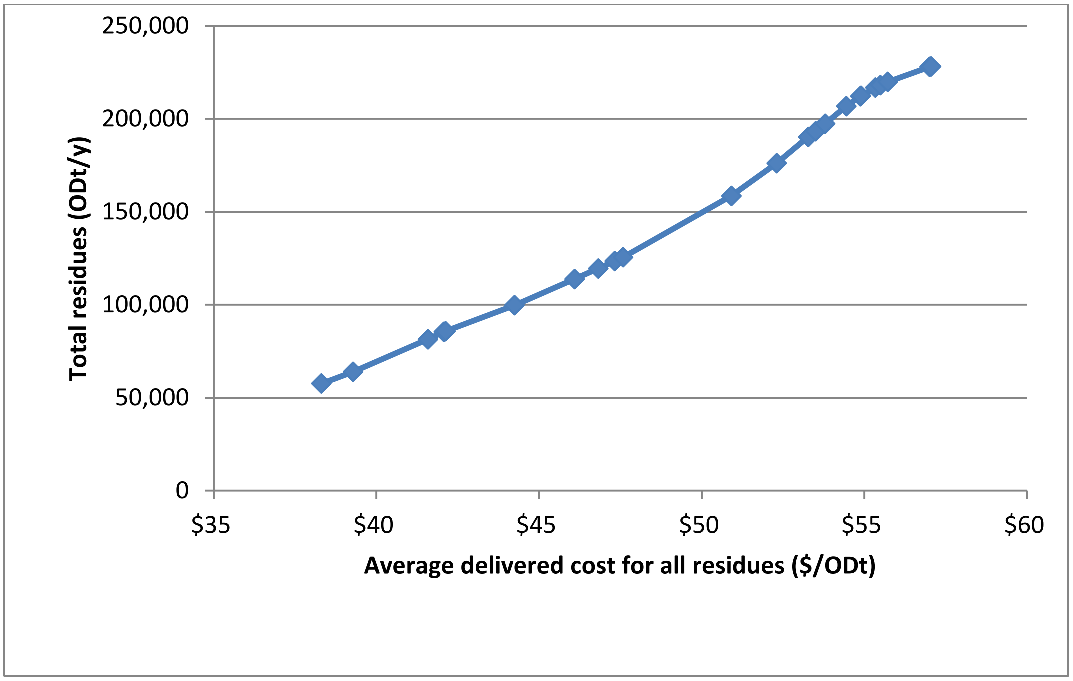

Figure 3 Total residue volume versus average delivered cost.

No water transportation

Omitting the supply areas that require water transportation results in a slightly different cost and volume relationship.

Table 16 shows there are about 115,000 ODt/y of roadside and dispersed residues from supply areas that are accessible by road. Adding the 40,000 ODt of sortyard residues brings the total to about 155,000 ODt/y at an average cost of $52.63/ODt.

Selection	Number of supply areas selected	Roadside residue biomass (ODt/y)	Average transportation cost ($/ODt)	Dispersed residue (ODt/y)	Roadside and dispersed (ODt/y)	Average delivered cost ($/ODt)
All supply areas	23	108,497	$35.67	79,650	188,147	$56.93
Road-accessible supply areas	13	65,115	$32.78	50,241	115,356	$52.63

Table 16 Roadside and dispersed residues from road-accessible supply areas.

Dryland sort residue percentage

The sortyard residue volumes were calculated using a rate of 3% of production. Using rates of 2% and 5% respectively generated estimates of 27,000 and 67,000 ODt/y compared to the base case of 40,000 ODt/y (Table

17). In all cases, the costs were assumed to remain constant at $34/ODt, including transportation to the destination. Some residues from dryland sorts may already be committed to established buyers.

Scenario	Annual production (m^3/y)	Residue generation rate (% of solid wood)	DLS residue (ODt/y)
Low	3,333,376	2	26,667
Base	3,333,376	3	40,000
High	3,333,376	5	66,668

Table 17 Annual production and DLS residue at selected conversion rates.

Sensitivity analysis summary

Table 18 summarizes the cost and volume effects of the various parameters in the sensitivity analysis. The total volume for each variation of each scenario (except the dryland sort scenario) consists of the roadside, dispersed and sortyard residues, which was generally set to 40,000 ODt/y.

Parameter to vary	Low Volume		Base		High Volume	
	Biomass volume (ODT/y)	Delivered cost ($/ODT)	Biomass volume (ODT/y)	Delivered cost ($/ODT)	Biomass volume (ODT/y)	Delivered cost ($/ODT)
Harvest volume	179,635	$57.41	228,147	$56.93	277,270	$54.50
Transition rate to second growth[3]	232,214	$57.02	228,147	$56.93	238,066	$57.17
Accessibility by chip vans	175,553	$54.70	228,147	$56.93	322,852	$59.07
Biomass ratio and dispersed residues	152,885	$54.18	228,147	$56.93	273,846	$58.04
Transportation cost threshold[4]	119,435	$46.71	228,147	$56.93	206,772	$54.43
No water transportation	155,356	$52.55	228,147	$56.93	-	-
Dryland sort residue production	26,667	$34.00	40,000	$34.00	66,668	$34.00

Table 18 Summary of sensitivity analysis for Campbell River biomass availability.

VI. Considerations for recovering coastal forest feedstock

The assessment was also to include a summary the items to consider when recovering biomass in a coastal BC context (Appendix 5). Items such as feedstock moisture content, salt contamination, tenure, and fibre agreements play an important role in assessing the viability of the feedstock supply, but their detailed analysis are beyond the scope of the analysis.

[3] "Low" volume is for the gradual increase to more second-growth, and "high" volume is for the accelerated increase.
[4] "Low" volume is for $36/ODt maximum transportation cost and "high" volume is for the $42/ODt maximum transportation cost.

VII. Conclusions

In 2009, FPInnovations produced an Assessment of Economically Accessible Biomass for Vancouver Island and the BC southern mainland. The BC Ministry of Jobs, Tourism, and Skills Training and the Campbell River Economic Development Corp requested FPInnovations to provide a more detailed assessment of the biomass available near Campbell River, as a tool for potential biomass investors. This assessment considered the forest-origin biomass that could be recovered from 23 supply areas near Campbell River. The base case analysis of all 23 supply areas showed that approximately 228,000 ODt/y of biomass from roadside, dispersed, and sortyard residues could be recovered at an average delivered cost of $56.93/ODt.

By comparison the 2009 assessment showed approximately 211,000 ODt/y of forest-origin biomass was available to Campbell River, however, the two assessments use different assumptions about harvest volumes, accessibility, and biomass ratios that must be considered. The current assessment was based on an annual harvest of 5.14 M m^3 from the 23 supply areas, compared to 5.34 M m^3 in the 2009 assessment, and the proportion of the land base that is deemed to be accessible by conventional semi-trailer chip vans was reduced for the new assessment. Both these assumptions caused the volume to be reduced. On the other hand, the biomass ratios were adjusted upwards from the 2009 values, and the current base case assessment was for all 23 supply areas, including those omitted from the 2009 assessment that are accessible only by water, which caused the volume to increase.

The amount of recoverable biomass is partly determined by the land and resource characteristics and partly by the maximum price the customer is willing or able to pay. The total delivered costs from some supply areas exceed their expected value as biomass and should be excluded from the analysis. Capping the maximum transportation cost or omitting all supply areas that require water transport are two methods to present a more realistic estimate. A maximum transportation cost of $36/ODt generated about 120,000 ODt/y of total biomass at an average delivered cost of $46.71/ODt, and omitting all the water-based supply areas generated 155,000 ODt/y at an average delivered cost of $52.55/ODt.

These costs represent a blended average from all sources, including $24/ODt for grinding and loading roadside residues. It also includes a significant amount of biomass from dispersed residues from avoidable waste that is assumed to be harvested at $5/ODt more than the roadside residues and a substantial amount of sortyard residues that are costed at $34/ODt including transportation.

The amount of available biomass is also influenced significantly by equipment selection and management decisions. FPInnovations calculated that increasing the accessibility to the various operating areas, perhaps by using different truck configurations, could increase the available biomass by almost 95,000 ODt/y if recovery occurred from all the supply areas. The increase would be less if biomass was recovered only from the road-accessible supply areas. Changing the biomass ratio by changing utilization standards could shrink or grow the amount of biomass by 45,000 to 75,000 ODt/y. Varying the harvest rates through the range experienced between 2006 and 2011 changed the amount of biomass up or down by 50,000 ODt/y. Accelerating the transition to more second-growth harvesting would add 10,000 ODt/y.

Approximately 65% of the biomass was hemlock, 26% Douglas-fir, and 10% western cedar. Two-thirds of the biomass was from second-growth. Biomass would typically be produced in a mix of all species and ages, and any additional cost required to segregate the biomass by species or age was not considered in the analysis.

VIII. References

MacDonald, AJ 2009. Assessment of Economically Accessible Biomass. FPInnovations TR for BC Coastal Forest Sector Hem-Fir Initiative, Vancouver, BC.

Forrester, P.D. 1996. Fibre recovery from log sortyard residues on Coastal British Columbia, FERIC, Vancouver, BC, TN-249.

Ministry of Forest. BC Harvest Billing System, https://www15.for.gov.bc.ca/hbs/home.jsp

IX. Appendices

Appendix 1 Biomass ratios used for sensitivity analysis.

Stand attributes, bucking			Biomass ratio (%)			
			Ground (and cable) harvesting		Aerial harvesting	
Species	Age	Biomass Ratio Level	Logs to roadside	Trees to roadside	Logs to roadside	Trees to roadside
C	OG	Low	6	8	2	2
H	OG		10	12	2	2
F	OG		8	10	2	2
F	SG		7	10	1	1
C	SG		7	10	1	1
H	SG		8	10	1	1
H	OG	Medium	13	15	2	2
F	OG		10	12	2	2
C	OG		8	10	2	2
F	SG		9	15	2	2
C	SG		9	15	2	2
H	SG		10	15	2	2
F	OG	High	15	18	4	4
H	OG		18	20	4	4
C	OG		10	12	4	4
C	SG		12	20	3	3
F	SG		12	20	4	4
H	SG		12	20	4	4

Appendix 2 Major licensees operating near Campbell River.

BC Timber Sales Contact: Don Hudson 370 S Dogwood Street Campbell River, BC Telephone: 250 268-9300
Island Timberlands Contact: Kevin Ashfield 1420 East Island Highway, Nanoose Bay, BC 250 755-3500
Western Forest Products Inc. Contact: Brendan Mohan Bag 5000 1921 SW Main Port McNeill, BC 250 956-3832
TimberWest Forest Corp. Contact: John Mitchell #3-4890 Rutherford Road Nanaimo, BC 250 729-3700

Appendix 3 Proportion of total harvest from second-growth stands.

	Second Growth Proportion of Total Harvest		
Supply Area	Current	Gradual Transition	Accelerated Transition
Nimpkish - rail	28%	35%	50%
Woss/Vernon	12%	20%	25%
Johnson	35%	40%	50%
Eve River	9%	15%	25%
Tsitika River	35%	45%	50%
Sayward-West	9%	15%	25%
Sayward-East	9%	15%	25%
Sayward-Strathcona	91%	93%	95%
Elk River	93%	94%	95%
Courtenay/Cumberland	93%	94%	95%
Oyster	7%	15%	25%
Upper Salmon River	0%	5%	10%
Knight Inlet	10%	15%	20%
Loughborough-North	40%	45%	50%
Phillips Arm-North	10%	15%	20%
Phillips Arm-South	50%	55%	65%
Lapan/Tom Browne Lake	95%	95%	96%
John Strait Islands	100%	100%	100%
Islands	60%	65%	75%
Mainland	50%	55%	60%
Acteon Sound	10%	15%	20%
Loughborough-South	50%	55%	60%
TFL37 takeback	12%	20%	25%

Appendix 4 Proportion of supply area accessible by chip van.

Supply area	Proportion of supply area accessible by chip van					
	Low		Base		High	
	OG	SG	OG	SG	OG	SG
Nimpkish - rail	20%	40%	30%	50%	50%	80%
Woss/Vernon	20%	40%	30%	50%	50%	80%
Johnson	30%	60%	40%	70%	80%	80%
Eve River	30%	60%	40%	70%	80%	80%
Tsitika River	30%	60%	40%	70%	80%	80%
Sayward-West	30%	60%	40%	70%	80%	80%
Sayward-East	30%	60%	40%	70%	80%	80%
Sayward-Strathcona	30%	60%	40%	70%	60%	80%
ElkRiver	60%	60%	80%	80%	90%	90%
Courtenay/Cumberland	10%	30%	20%	40%	90%	90%
Oyster	40%	60%	50%	70%	60%	80%
Upper Salmon R	40%	40%	50%	50%	50%	60%
Knight Inlet	10%	60%	20%	80%	50%	90%
Loughborough-North	10%	30%	20%	40%	50%	60%
Phillips Arm-North	10%	30%	20%	40%	50%	60%
Phillips Arm-South	10%	60%	20%	80%	50%	90%
Lapan/Tom Browne Lake	10%	60%	20%	80%	50%	90%
John Strt. Islands	10%	60%	20%	80%	50%	90%
Islands	5%	5%	20%	40%	30%	60%
Mainland	0%	0%	5%	20%	10%	30%
Acteon Snd	0%	0%	5%	20%	10%	30%
LoughboroughTSA-South	10%	20%	20%	40%	90%	90%
TFL37 takeback	10%	30%	20%	40%	50%	50%

Appendix 5 Considerations for recovering coastal forest feedstock.

Overview

The recovery and use of forest feedstock from British Columbia's forests has increased in recent years, mainly to service co-generation plants in pulp and paper mills. Development of alternative uses for forest feedstock such as stand-alone power plants, pellet mills, or more sophisticated technologies will require secured fibre supplies, including residues from harvesting operations. Open burning smoke control regulations may also restrict the burning of logging residue and thus increase the need to recover harvest residues. Recovering the harvesting residues under coastal conditions or using coastal sawmill residues requires different considerations than similar operations in the Interior, including:

- Feedstock moisture content
- Feedstock salt contamination
- Steep terrain and roads
- Tenure
- Effects of utilization standards and old-growth/second-growth

This document addresses these issues with some basic background information.

Moisture Content

Moisture content plays an important role in the logistics of forest feedstock extraction. Coastal feedstock is typically over 40% moisture content and can often exceed 50%, and strategies must be incorporated to offset the associated costs caused by high moisture.

Higher moisture content reduces boiler efficiency because the energy used to drive off the excess moisture is not available for output. It also leads to longer residence time in the boiler to complete combustion.

High moisture content can significantly increase the transportation cost. For example, a load of feedstock that weighs 20 green tonnes at 50% moisture content contains 10 oven dry tonnes of biomass and 10 tonnes of water, while the same load contains 13 oven dry tonnes of biomass and 7 tonnes of water if the feedstock is dried to 35%. The reduced net payload at higher moisture content will significantly increase the cost of net energy delivered.

Piling residues to dry is a common technique when burning roadside residues, but piles left for an entire winter may regain most of their original moisture content from snow and rain. Techniques such as tarping of residue piles help to deflect moisture from entering the pile before comminution. Such techniques are used in Scandinavia, but have not been used in western Canada. Covered storage of comminuted biomass also helps to maintain drier feedstock and higher energy content.

Salt Contamination

In coastal BC, the ocean provides for economic transportation and convenient storage grounds for harvested logs. However, hog fuel from logs that are transported or stored in salt water is high in salt content, and can create dioxins when burnt, which can pose a significant health hazard. High salt content may also lead to increased corrosion in plant infrastructure. Direct transport to the plant by truck, or shortened storage time in salt water will reduce but may not eliminate the salt content.

Steep Terrain and Roads

Much of coastal BC is defined by steep terrain that can increase the challenge of harvesting the feedstock since grinders and chippers generally need flat ground to perform well. Steep slopes inhibit their ability to load directly into the trucks and create an operational safety hazard if traction is poor. Grinders may have difficulty working successfully on small landings on steep terrain.

Steep, narrow or winding roads make it difficult to get larger trucks such as B-trains and long chip vans into the cutover. Lack of traction can be a problem for empty trucks and tight corners can limit the length of truck that can be used.

Currently, successful coastal biomass operators use a variety of smaller bin trucks to extract feedstock material. Although these trucks allow feedstock recovery from difficult areas, their smaller capacity increases the transport cost. FPInnovations' "Biomass Trucks and Resource Road Standards" guidebook provides field planners with a practical tool to assess the suitability of different truck configurations on different road standards.

The landbase from which biomass can be extracted must be netted-down to account for steep terrain, or alternative, and more costly, recovery systems must be implemented to move the biomass to a more suitable location for comminution.

Tenure

Some form of tenure or permission is required to recover the residual harvesting biomass, and Coastal tenure has both similarities and differences from other areas of BC.

Public forest land

Public forest land in BC is managed by licensees and administered by the Ministry of Forests, Lands and Natural Resources Operations. Recently, the BC government amended the Forest Act to include two new tenure types specific to biomass. The Fibre Supply Licence to Cut and the Fibre Forestry Licence to Cut both authorize the processing for chips and hogged tree material and removal of Crown timber. Although these new tenures may allow for new licences between the Crown and a biomass company without involving the primary licence holder, businesses are encouraged to create agreements with the primary licence holder to achieve maximum efficiency (e.g., sorting, chipping and grinding of residues may be coordinated with the primary harvester).

Private forest land

Private land occupies a much higher proportion of forested land on the Coast than in the Interior. Although coastal forested land is roughly one third the size of interior forested land, it contains 60% of the private forest land in BC most of which is located on the south and eastern portions of Vancouver Island. All residue recovery operations on private land must be done in cooperation with the private landowner.

Private landowners generally have more flexibility in harvest timing and can respond more quickly than public-land licensees to changing market conditions. Timber harvested from private land is not subject to stumpage payments to the Crown, however, the landowners must pay property taxes based on the assessed land values.

Fibre agreements

A complex series of fibre agreements exist between forest licensees, private landowners, and the mill owners in coastal BC. These agreements date back thirty or more years through numerous company ownership and tenure changes, and can limit the flexibility of the forest companies to enter into new fibre-supply agreements. In turn, this can limit the amount of biomass available in a given area. These fibre agreements must be considered for any new biomass-focused ventures.

Effects of utilization standards

Utilization standards influence the volume of potential biomass available for recovery by changing the amount of sawlogs harvested, and thus the amount of residues, from any specified stand quality. Implementing smaller topping diameters generally yields more sawlog and pulp volume and less biomass volume. Trees that are currently bypassed as uneconomical due to size, species or quality may have value as biomass.

Private landowners may be more flexible in their utilization standards and sensitive to changing market conditions than operators on public land.

Old growth versus second growth

The coastal industry continues its transition to cutting more second growth timber, which usually generates more roadside residues per hectare than old growth. Second growth trees are generally more flexible than old growth, contain fewer defects, and undergo less breakage in the logging process. As a result, more intact trees reach roadside where they are processed into merchantable logs and the tops could become available as residual biomass. Old growth trees tend to have a higher percentage of rot and defect which could be available as biomass, but is more difficult to collect because it is usually dispersed across the cutover. Old growth residues often contain large pieces, thus requiring large comminution equipment. Old growth stands tend to be located on the more difficult terrain and road systems.

Some old-growth stands that consist mainly of western hemlock and amabilis fir have been considered as uneconomic for harvesting sawlogs in the past, and may become economic if there is a viable market for biomass.

Other differences between Coastal and Interior biomass recovery

With their proximity to the ocean, coastal communities have a limited land base from which they can recover biomass since much of the surrounding area is covered by water. This tends to limit the amount of biomass that can be recovered to a specific location. By contrast, many Interior communities can recover biomass from all directions.

Although proximity to the ocean limits the land base where biomass can be recovered using conventional systems and truck transport, harvest residual feedstock could be transported from remote locations by barge. New infrastructure would be required to recover and transport such feedstock.

The Interior currently has large volumes of lodgepole pine killed by the mountain pine beetle. These trees begin to degrade and the sawlog portion of the stand is reduced within years after mortality. Industry is currently salvaging as much of the available sawlog as possible, thus generating significant residue volumes. Residue from these stands is considered to be high quality for its low moisture and bark content, and significant quantities have been shipped to the coast for greenhouse heat and co-generation electricity.

The Coast and the Interior each harvest three to five main species although each has a different species mix. The coast generally harvests Douglas-fir, western red cedar, western hemlock, amabilis fir and cypress, with minor amounts of red alder, cottonwood and big leaf maple that are felled but not usually transported from the cutblock. The species mix affects wood density, which subsequently affects the combustion energy content per unit of volume, but it is not yet well understood whether any species offers a clear advantage for non-combustion processes. However, coastal feedstock generally contains more moisture than interior feedstock, which can affect combustion and non-combustion conversion processes.

Summary

Special considerations should be made when recovering coastal harvest residues or utilizing sawmill residues.

1. High moisture content reduces boiler efficiency and increases the cost of net energy delivered.
2. Burning salt-laden hog can create dioxins and lead to plant infrastructure corrosion.
3. Steep terrain and roads create a physical challenge for extraction and increase the recovery cost.
4. The high proportion of private land on the coast may result in more business to business agreements than government-licenced tenures compared to other areas of BC.
5. Existing fibre agreements between established industries may limit the forest companies' flexibility to consider new biomass-focused ventures.
6. Utilization standards can affect the amount of biomass available for harvest. Private landowners may have more flexibility to change utilization standards on short notice.
7. The transition to second growth harvesting is creating more roadside biomass than was generated from old growth harvesting.
8. The coast also differs from the Interior by its restricted road access to much of the land base, the interior's large volume of beetle-killed lodgepole pine and the difference in species mix between the two regions.