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# **Volume to Biomass Conversion Additional Utilization Levels**

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## 1. Introduction

Kivari et al. (2010) produced volume to biomass conversion factors for the 4.0 utilization level. That is, they produced factors to convert whole stems volume (m<sup>3</sup>/ha) of trees with Dbh ≥ 4.0cm to biomass (T/ha) of trees with Dbh ≥ 4.0cm. This report reports factors to convert biomass at the 4.0 cm utilization level to other utilization levels.

## 2. Methods

Biomass estimates using the conversion factors developed by Kivari et al. (2010) are considered the baseline. Biomass for different utilization levels is estimated from the 4.0 cm utilization level.

### 2.1 Data

The compiled tree level data were obtained from the Ministry of Forests and Range. This consisted of the relevant individual tree measurements and estimates by plot. For each tree the following information was available – species group (sp0), BEC (beczone), diameter at breast height (Dbh), status (live or dead), whole stem volume per hectare (vha\_wsv) as well as the biomass per hectare of the biomass components (biomass\_wood\_ha, biomass\_branches\_ha, biomass\_bark\_ha, biomass\_foliage\_ha), and specific gravity (density). For some trees, age\_total was available. Table 1 summarizes by data source. Trees with negative estimates for biomass components were removed from further analysis.

Table 1. The datasets are summarized by data source.

Source	Dbh limit (cm)	Dbh (cm)	N (Dbh and Height)	Height (m)	Age total (years)	N (age)
audit	12.5	40.2 (12.5 - 931)	127,793	23.1 (0.7 - 75)	159 (1 - 997)	11,726
psp	2.0	14.4 (1.9 - 389.5)	1,270,582	13.8 (0.5 - 87.3)	80 (4 - 940)	79,594
tsp	7.5	24.2 (7.5 - 457.2)	4,384,849	18 (1.8 - 89.6)	68 (0 - 996)	447,959
vri	4.0	34.3 (4 - 740.4)	83,492	20 (1.3 - 75)	142 (11 - 3000)	16,173

The sample sizes by utilization and sp0 are given in Figure 1. The sample sizes increase rapidly from the 2.0cm to 7.5cm utilization level due to including more of the datasets in Table 1.

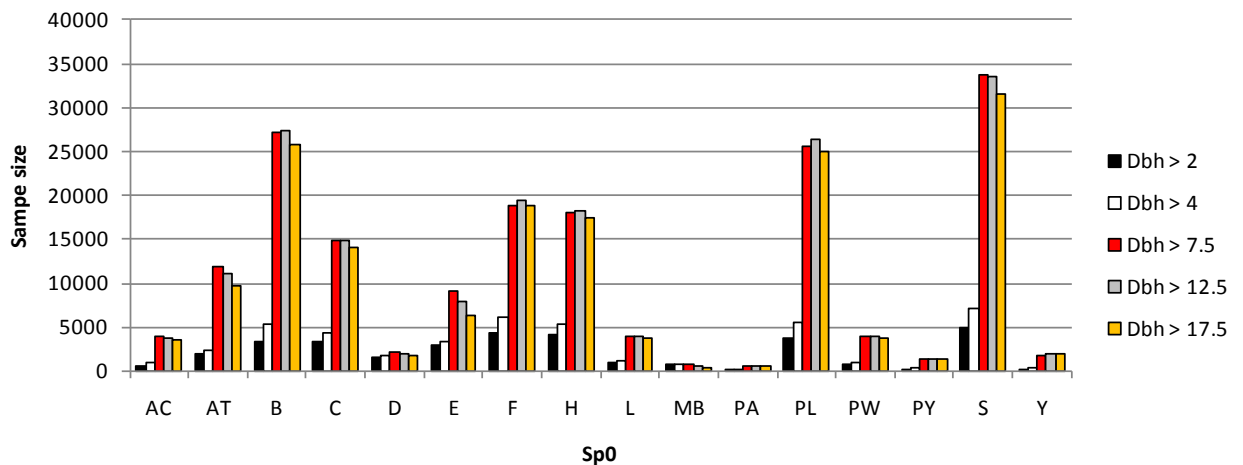


Figure 1. The sample size is given for each Sp0 and by utilization.

**2.2 Additional utilization levels**

Not all species occurred in all beczones so ratios for all beczones combined were also estimated.

The ratio of biomass at the 2.0 cm utilization to the biomass at the 4.0 utilization level is  $\geq 1.0$  and is based only on the PSP data (the only dataset to go down to a 2.0 cm utilization). The rest of the ratios are based on the PSP and VRI data (the datasets that go to the 4.0cm utilization level).

**3. Results**

Sample results are given in Table 2. Results for the remaining utilization levels are given in the excel spreadsheet "Results\_ratio.xlsx".

Table 2. The ratio of biomass at the 2cm utilization level to the biomass at the 4.0cm utilization is given by component, sp0 and BEC zone.

Component	SP0	BEC zone													
		All	AT	BG	BWBS	CDF	CWH	ESSF	ICH	IDF	MH	MS	PP	SBPS	SBS
Wood	AC	1.0003			1.0007		1.0001	1.0269	1.0000	1.0000		1.0000		1.0000	1.0002
Wood	AT	1.0005			1.0004		1.0000	1.0001	1.0004	1.0007		1.0000	1.0000	1.0000	1.0007
Wood	B	1.0004			1.0045	1.0000	1.0001	1.0021	1.0009	1.0001	1.0000	1.0037	1.0000	1.0052	1.0019
Wood	C	1.0004				1.0000	1.0001	1.0020	1.0024	1.0017		1.0279	1.0000		1.0175
Wood	D	1.0001			1.0000	1.0000	1.0001	1.0000	1.0001	1.0008		1.0000		1.0000	1.0041
Wood	E	1.0017			1.0084	1.0000	1.0000	1.0006	1.0002	1.0007		1.0003		1.0000	1.0006
Wood	F	1.0001				1.0000	1.0000	1.0000	1.0003	1.0016		1.0007	1.0011	1.0020	1.0005
Wood	H	1.0001				1.0000	1.0001	1.0008	1.0010	1.0001	1.0000	1.0000			1.0002
Wood	L	1.0001			1.0000		1.0000	1.0000	1.0001	1.0001		1.0007			1.0000
Wood	MB	1.0000				1.0000	1.0000	1.0000	1.0001	1.0002		1.0000			1.0117
Wood	PA	1.0037						1.0037				1.0000			
Wood	PL	1.0008			1.0011	1.0000	1.0004	1.0004	1.0003	1.0010		1.0006	1.0000	1.0019	1.0008
Wood	PW	1.0002				1.0000	1.0000	1.0000	1.0003	1.0000		1.0000			
Wood	PY	1.0002							1.0000	1.0001		1.0000	1.0002		
Wood	S	1.0001			1.0029	1.0000	1.0000	1.0003	1.0002	1.0007		1.0002	1.0000	1.0016	1.0004
Wood	Y	1.0000					1.0000				1.0000				
Branches	AC	1.0002			1.0012		1.0001	1.0277	1.0000	1.0000		1.0000		1.0000	1.0002
Branches	AT	1.0006			1.0007		1.0000	1.0001	1.0003	1.0007		1.0000	1.0000	1.0000	1.0007
Branches	B	1.0035			1.0218	1.0000	1.0022	1.0048	1.0029	1.0003	1.0000	1.0084	1.0000	1.0174	1.0047
Branches	C	1.0000				1.0000	1.0000	1.0002	1.0002	1.0002		1.0020	1.0000		1.0016
Branches	D	1.0007			1.0000	1.0000	1.0008	1.0000	1.0005	1.0048		1.0000		1.0000	1.0017
Branches	E	1.0008			1.0074	1.0000	1.0000	1.0003	1.0001	1.0005		1.0002		1.0000	1.0004
Branches	F	1.0009				1.0002	1.0000	1.0001	1.0005	1.0022		1.0009	1.0015	1.0026	1.0007
Branches	H	1.0042				1.0001	1.0024	1.0270	1.0160	1.0009	1.0000	1.0000			1.0064
Branches	L	1.0001			1.0000		1.0000	1.0000	1.0000	1.0000		1.0003			1.0000
Branches	MB	1.0000				1.0000	1.0000	1.0000	1.0000	1.0003		1.0000			1.0092
Branches	PA	1.0154						1.0154				1.0000			
Branches	PL	1.0020			1.0023	1.0000	1.0011	1.0010	1.0006	1.0023		1.0015	1.0000	1.0052	1.0021
Branches	PW	1.0123				1.0000	1.0001	1.0000	1.0145	1.0000		1.0000			
Branches	PY	1.0108							1.0000	1.0145		1.0000	1.0099		

## Volume to Biomass Conversion by Utilization Level

Component	SPO	BEC zone														
		All	AT	BG	BWBS	CDF	CWH	ESSF	ICH	IDF	MH	MS	PP	SBPS	SBS	SWB
Branches	S	1.0013			1.0118	1.0004	1.0001	1.0058	1.0029	1.0071		1.0018	1.0000	1.0119	1.0060	
Branches	Y	1.0016					1.0016				1.0000					
Bark	AC	1.0010			1.0034		1.0001	1.0290	1.0000	1.0000		1.0000		1.0000	1.0002	
Bark	AT	1.0007			1.0008		1.0000	1.0001	1.0008	1.0007		1.0000	1.0000	1.0000	1.0007	
Bark	B	1.0012			1.0017	1.0000	1.0004	1.0035	1.0017	1.0002	1.0000	1.0060	1.0000	1.0114	1.0033	
Bark	C	1.0007				1.0000	1.0001	1.0028	1.0035	1.0026		1.0377	1.0000		1.0209	
Bark	D	1.0002			1.0000	1.0000	1.0002	1.0000	1.0003	1.0021		1.0000		1.0000	1.0071	
Bark	E	1.0024			1.0105	1.0000	1.0000	1.0004	1.0002	1.0008		1.0003		1.0000	1.0006	
Bark	F	1.0001				1.0001	1.0000	1.0000	1.0002	1.0008		1.0003	1.0006	1.0010	1.0002	
Bark	H	1.0005				1.0000	1.0003	1.0049	1.0043	1.0003	1.0000	1.0000			1.0009	
Bark	L	1.0001			1.0000		1.0000	1.0000	1.0000	1.0000		1.0003			1.0000	
Bark	MB	1.0000				1.0000	1.0000	1.0000	1.0002	1.0003		1.0000			1.0128	
Bark	PA	1.0048						1.0048				1.0000				
Bark	PL	1.0026			1.0026	1.0000	1.0015	1.0012	1.0008	1.0029		1.0020	1.0000	1.0068	1.0027	
Bark	PW	1.0014				1.0000	1.0000	1.0000	1.0018	1.0000		1.0000				
Bark	PY	1.0028							1.0000	1.0024		1.0000	1.0053			
Bark	S	1.0007			1.0078	1.0001	1.0000	1.0040	1.0016	1.0043		1.0018	1.0000	1.0054	1.0022	
Bark	Y	1.0009					1.0009				1.0000					
Foliage	AC	1.0060			1.0264		1.0001	1.0520	1.0001	1.0000		1.0000		1.0000	1.0002	
Foliage	AT	1.0040			1.0125		1.0000	1.0001	1.0003	1.0008		1.0000	1.0000	1.0000	1.0007	
Foliage	B	1.0066			1.0210	1.0000	1.0033	1.0162	1.0095	1.0020	1.0000	1.0257	1.0000	1.0270	1.0149	
Foliage	C	1.0029				1.0000	1.0007	1.0076	1.0099	1.0092		1.0756	1.0000		1.0294	
Foliage	D	1.0020			1.0003	1.0000	1.0021	1.0000	1.0143	1.2111		1.0104		1.0000	1.0135	
Foliage	E	1.0084			1.0535	1.0000	1.0003	1.0007	1.0014	1.0040		1.0028		1.0000	1.0029	
Foliage	F	1.0023				1.0013	1.0000	1.0002	1.0014	1.0059		1.0023	1.0031	1.0063	1.0020	
Foliage	H	1.0067				1.0001	1.0039	1.0349	1.0192	1.0011	1.0000	1.0000			1.0103	
Foliage	L	1.0001			1.0000		1.0000	1.0000	1.0000	1.0001		1.0004			1.0000	
Foliage	MB	1.0004				1.0003	1.0004	1.0000	1.0004	1.0008		1.0000			1.0147	
Foliage	PA	1.0345						1.0345				1.0000				
Foliage	PL	1.0127			1.0085	1.0000	1.0076	1.0045	1.0031	1.0114		1.0103	1.0000	1.0338	1.0133	
Foliage	PW	1.0268				1.0000	1.0003	1.0000	1.0293	1.0000		1.0000				
Foliage	PY	1.0146							1.0000	1.0216		1.0000	1.0122			
Foliage	S	1.0014			1.0290	1.0012	1.0001	1.0074	1.0040	1.0086		1.0024	1.0000	1.0285	1.0101	
Foliage	Y	1.0097					1.0098				1.0000					

## 4. Implementation

To calculate the biomass to the various utilization levels, first convert the whole stem volume to biomass at the 4.0 cm utilization level using the coefficients in Kivari et al. (2010). Then use the ratios found in the spreadsheet "Results\_ratios.xlsx".

To calculate the biomass at the 2.0cm utilization level, multiply the biomass at the 4.0cm utilization level by the ratio for the corresponding component, sp0 and beczone. There is no ratio for the beczone, use the ratio for all beczonees combined.

## **5. Literature Cited**

Kivari, A., W. Xu and S. Otukol. 2010. Volume to biomass conversion for British Columbia Forests. Ministry of Forests and Range, Forest Analysis and Inventory Branch. Draft dated September 2010.