# Appendices

# Appendix 1 Full CGNF Tree – Step by Step Example

This appendix will demonstrate how to calculate the volume for a tree using Kozak's taper equation, and will provide the associated regression coefficients and inflexion points. The volume is calculated for three sections of the tree. Section 1 is the stump, section two is the merchantable volume, and section 3 is the top of the tree. Hence, by applying these steps, both the total biological volume and the merchantable volume are calculated.

The merchantable portion of the tree is between the stump height and the height where the merchantability requirement top diameter is achieved. This portion is divided into logs based on the cruiser's selection of preferred lengths up to the merchantable top.

The last merchantable log is generally shorter than the other logs. If the last log is less than the minimum allowable length for the grade of the log, then its length and volume is added to the second to last log. The grade of the last log will take on the grade of the second to last log and the net factors are combined and weighted based on the log lengths.

There are two equations that must be used in order to determine the volume of the tree. The first is the taper equation, used to determine the diameter inside bark at a specified height above the ground. The second equation calculates the volume of a log given an upper and lower height above the ground, with associated diameters.

**Taper Equation**

$$d_i = a_1 D^{a_2} a_3^{D} X^{exp}$$

Where:

$d_i$ = diameter inside bark in cm at height $h_i$ from the ground

$exp$ = $a_4 z^2 + a_5 \ln(z + 0.001) + a_6 \sqrt{z} + a_7(D/H) + a_8 e^z$

$D$ = diameter at breast height in cm

$X$ = $(1 - \sqrt{h_i / H}) / (1 - \sqrt{p})$

$H$ = total height of tree in meters

$h_i$ = height from ground in meters

$z$ = $h_i/H$

$p$ = inflection point, see the end of this Appendix

$a_1 \ldots a_8$ = regression coefficients, see the end of this Appendix

*ln* = natural logarithm

*e* = 2.718281828

**Volume Calculation**

The CGNF compiler uses Smalian's formula for calculating log volumes. To derive a tree's merchantable volume, calculate and accumulate each individual log's volume.

**Calculation of Log Volumes**

The log is first cut into smaller segments and the volume of each segment is calculated and summed. The segment length used is 10 cm.

The "*i*" subscript in the following formulas refers to a segment's attribute.

$$Vl = \sum_{i=1}^{n} Vs_i$$ Volume of the Log in $m^3$

$$Vs_i = \frac{Ab_i + At_i}{2} \times Ls$$ Volume of a segment, using Smalian's Formula in $m^3$

$$Ls = \frac{L}{n}$$ Segment Length in m

$$A = \frac{D^2 \times \pi}{4}$$ Cross section Area in $m^2$

Where:

*Vl* = Log Volume ($m^3$)

*Vs* = Volume of a Segment ($m^3$)

*Ab* = Area of the Segment's Top ($m^2$)

*Ls* = Segment Length (m)

*L* = Log Length (m)

*n* = Number of Segments in a Log

$D^2$ = Diameter squared (m)

$A$ = Cross section area ($m^2$)

**Last Log Logic:**

If the last log in a tree is shorter than the minimum for the species and grade assigned, then the last log is combined with the second to last log and assigned the second to last log's grade. The log lengths are combined, the net factors are combined and weighted by the log's length. See Appendix 1, step 2.3 and 2.4.

**Steps for Calculating the Volume of a Tree**

An example of the volume calculations for a single tree is given. Please refer to Appendix 2 for log grade validations, Appendix 3 for CGNF breakage tables, and Appendix 4 for net volume adjustment factors.

**Example #1:**

The tree parameters are:

| | |
|---|---|
| **Species:** | **Cypress** |
| DBH: | 110.0 cm |
| Total Height: | 41.0 m |
| F.I.Z. | C |
| Stump Height: | 30 cm |
| Top Diameter: | 15.0 cm |
| Maturity: | Mature |
| Live/Dead: | Live |

The log parameters are (as recorded by the cruiser):

| Log # | Grade | Log len (m) | Net factor (%) |
|---|---|---|---|
| 1 | Z | 1 | 100 |
| 2 | D | 8 | 100 |
| 3 | H | 13 | 90 |
| 4 | U | 11 | 93 |
| 5 | X | 99* | 70 |

* A “99” log length instructs the compiler program to extend the length of the last log up to the merch height of the tree (to the utilization limit).

Step 1 Look up the appropriate regression coefficients, $a_1$, $a_2$,, $a_8$ and the inflection point, $p$. These parameters are dependent on species and Forest Inventory Zone. They are provided in the tables in the back of this Appendix.

Cypress taper parameters for FIZs A, B andC are:

p = 0.30

$a_1$ = 0.928138

$a_2$ = 0.945293

$a_3$ = 0.999206

$a_4$ = 0.301423

$a_5$ = -0.040792

$a_6$ = -1.235630

$a_7$ = 0.030743

$a_8$ = 0.672879

Step 2 Determine the biological and gross merchantable volume.

2.1 Calculate the diameter inside bark at stump height using the taper equation. Substitute the stump height for $h_i$ (if the resultant diameter is less than the specified top diameter, return 0 volume).

Solve the taper equation using 0.3 m as hi (only 9 decimal places are shown).

$X = (1 - \sqrt{0.3/41.0}) / (1 - \sqrt{0.3})$

$= (0.914460107\ldots) / (0.452277442)$

$= 2.021900767$

$Exp = a_4 z^2 + a_5 \ln(z + 0.001) + a_6 \sqrt{z} + a_7(D/H) + a_8 e^z$

$= 0.301423(0.30 / 41.0)^2 - 0.040792\ln((0.30 / 41.0) + 0.001)$

$- 1.235630\sqrt{0.3/41} + 0.030743(110.0 / 41.0)$

$+ 0.672879(2.718281828)^{0.30/41.0}$

$= 0.84999330$

$d_{30} = (0.928138(110.0)^{0.945293})(0.999206)^{110.0}(2.02190)^{0.84999330}$

$= 131.61$ cm

2.2 Calculate the merchantable height of the tree.

There are many ways to find the solution for the merchantable height. However, all methods use a binary search to iterate the proportion of the height at which merch height occurs. This method starts by substituting 0.9 (proportion of the total height to estimate the merch height) into the '$z_0$' variable in the exp equation calculated in step 2.1 above. Once the exp variable is calculated, it is substituted into the taper equation for (hi/H). This provides a new estimate of the proportion hi/H at the merch ht. The first estimated proportion is compared to the new estimated proportion. When the two proportions are less than 0.00001 different, then the iteration ends. This proportion is multiplied by the total height of the tree to obtain the merchantable height.

a. Start $hi/H = z_0 = 0.9$

Substitute 0.9 into the formula:

$Exp = a_4 z_0^2 + a_5 \ln(z_0 + 0.001) + a_6 \sqrt{z0} + a_7(D/H) + a_8 e^{z0}$

$= 0.301423(0.9)^2 - 0.040792\ln((0.9) + 0.001)$

$- 1.235630\sqrt{0.9} + 0.030743(110.0 / 41.0)$

$+ 0.672879(2.718281828)^{0.9}$

$= 0.81368015$

b. Substitute exp into the taper formula and solve for proportion hi/H = $z_1$

$z_1 = [1 - ((d_i / (a_1 * D^{a2} * a3^D)) (^{1 / exp})) * (1 - \sqrt{p}\,)]^{2}$

$= [1 - ((15 / (0.928138 * (110.0)^{0.945293} *$

$0.999206^{110.0}))^{1/0.81368015})) * (1 - \sqrt{0.3}\,)]^{2}$

$= 0.87345586$

c. Compare results of $z_0$ with $z_1$. Subtract one proportion from the other. If the result is < 0.00001 and number of iterations is < 10,000 then stop the iteration.

$= 0.9 - 0.87345586$

$= 0.026544$

d. Since the result of the test was > 0.00001, therefore, continue iteration by halving the estimate of the proportion until result is < 0.00001.

New $z_0 = (z_0 + z_1)/2$

$= (0.9 + 0.87345586) / 2$

$= 0.88672793$

e. Continue back to step 2.2.a until the test results in < 0.00001.

Here are the results of the iteration until a solution was found:

| exp | z0 | z1 | z0-z1 (<0.00001) |
|---|---|---|---|
| 0.813680155 | 0.9 | 0.87345587 | 0.026544 |
| 0.793992663 | 0.886727934 | 0.87918892 | 0.007539 |
| 0.788486514 | 0.882958425 | 0.88079644 | 0.002162 |
| 0.786914461 | 0.881877432 | 0.88125569 | 0.000622 |
| 0.786462942 | 0.881566559 | 0.88138761 | 0.000179 |
| 0.786333036 | 0.881477085 | 0.88142557 | 0.000052 |
| 0.786295642 | 0.881451327 | 0.88143650 | 0.000015 |
| **0.786284877** | **0.881443912** | **0.88143964** | **0.000004** |

z0-z1 = 0.881443912 – 0.88143964 = 0.000004 < 0.00001

Therefore, the iteration can stop.

f. Solve for merchantable height.

Merchantable height = last z0 * Total height

= 0.881443912 * 41.0

= 36.139 m

= 36.1 m

2.3 Calculate the length of the last log. Use this calculation even when a cruiser calls a length for the top log instead of 99.

Last log = merch. Height – (sum of log lengths) – stump height.

Last log = 36.14 - (1+8+13+11) - 0.30

= 3.14 - 0.30

= 2.84 m for last log of grade X

If the last log is less than the minimum log length for the species and grade, then append it to the second to last log.

For this example, since the last log is shorter than the minimum log length of 5.0m for X grade Yellow Cedar, the last log must be combined with the second to last log.

The last log now becomes 13.84m of U grade. There are now only 4 merchantable logs for this tree. Note: The remainder of the example will use only 4 logs in the calculations.

2.4 Calculate the new net factor for the last log ONLY if the last log is combined with the second to last log.

The log parameters are:

| Log # | Grade | Log len (m) | Net factor (%) |
|---|---|---|---|
| 1 | Z | 1 | 100 |
| 2 | D | 8 | 100 |
| 3 | H | 13 | 90 |
| 4 | U | 11 | 93 |
| 5 | X | 2.84 | 70 |

To calculate a new net factor for log # 4, simply weight the net factor of log # 4 and log # 5 by the log length of each and combine.

New Net Factor for log 4 = log 4 NF * log 4 len/ sum (log 4&5) +

log 5 NF * log 5 len/sum (log 4&5

= 93%*(11/13.84) + 70%*(2.84/13.84)

NF log 4 = 88.3%

| Log # | Grade | Log len (m) | Net factor (%) |
|---|---|---|---|
| 1 | Z | 1 | 100 |
| 2 | D | 8 | 100 |
| 3 | H | 13 | 90 |
| 4 | U | 13.84 | 88.3 |
| 5 | Combined with log 4 | | |

2.5 Calculate the top diameter of each merchantable log using the taper equation.

Consider a tree with four merchantable logs, with the following top heights and top diameters. See Step 2.1 above, for example of top diameter calculation.

| Log # | Grade | Log len (m) | Top Diameter |
|---|---|---|---|
| 1 | Z | 1 | 109.69 |
| 2 | D | 8 | 76.87 |
| 3 | H | 13 | 56.81 |
| 4 | U | 13.84 | 15.00 |
| 5 | Combined with log 4 | | |

2.6 Calculate the volume of the log using Smalian's volume equation, using 10cm segments.

Gross Merch volume of a Single Log - Use the taper equation to determine the 10 diameters for log # 1- grade Z, 1m length.

| Position | $h_i$ | $d_i$ - taper equation | Area ($m^2$) | Gross Volume ($m^3$) |
|---|---|---|---|---|
| stump | 0.3 m | 131.60 cm | 1.3603 | - |
| 1 | 0.4 m | 127.75 cm | 1.2817 | 0.1321 |
| 2 | 0.5 m | 124.60 cm | 1.2193 | 0.1250 |
| 3 | 0.6 m | 121.92 cm | 1.1674 | 0.1193 |
| 4 | 0.7 m | 119.59 cm | 1.1232 | 0.1145 |
| 5 | 0.8 m | 117.52 cm | 1.0848 | 0.1104 |
| 6 | 0.9 m | 115.67 cm | 1.0508 | 0.1068 |
| 7 | 1.0 m | 113.98 cm | 1.0204 | 0.1036 |
| 8 | 1.1 m | 112.44 cm | 0.9929 | 0.1007 |
| 9 | 1.2 m | 111.01 cm | 0.9679 | 0.0980 |
| 10 | 1.3 m | 109.69 cm | 0.9450 | 0.0956 |

Volume of Log # 1: sum each 10cm segment of the log for volume.

Vol Log $_1$ = Section 1 length * (Area (stump dia) + Area section 1) / 2 +

Section 2 length * (Area (section 1 dia) + Area section 2) / 2 +

Section 3 length * (Area (section 2 dia) + Area section 3) / 2 +

Section 4 length * (Area (section 3 dia) + Area section 4) / 2 +

Section 5 length * (Area (section 4 dia) + Area section 5) / 2 +

Section 6 length * (Area (section 5 dia) + Area section 6) / 2 +

Section 7 length * (Area (section 6 dia) + Area section 7) / 2 +

Section 8 length * (Area (section 7 dia) + Area section 8) / 2 +

Section 9 length * (Area (section 8 dia) + Area section 9) / 2 +

Section 10 length * (Area (section 9 dia) + Area section 10) / 2

Vol Log $_1$ = 0.1 * (1.3603 + 1.2817) / 2 +

0.1 * (1.2817 + 1.2193) / 2 +

0.1 * (1.2193 + 1.1674) / 2 +

0.1 * (1.1674 + 1.1232) / 2 +

0.1 * (1.1232 + 1.0848) / 2 +

0.1 * (1.0848 + 1.0508) / 2 +

0.1 * (1.0508 + 1.0204) / 2 +

0.1 * (1.0204 + 0.9929) / 2 +

0.1 * (0.9929 + 0.9679) / 2 +

0.1 * (0.9679 + 0.9450 / 2

**Vol Log 1 = 1.1061 m3**

Summary of volume by log:

| Log Position | Grade | Length (m) | hi (m) | Butt Dia (cm) | Top Dia (cm) | Gross Volume ($m^3$) |
|---|---|---|---|---|---|---|
| 1 | Z | 1 | 1.3 | 131.61 | 109.69 | 1.1061 |
| 2 | D | 8 | 9.3 | 109.69 | 76.87 | 4.9096 |
| 3 | H | 13 | 22.3 | 76.87 | 56.81 | 4.6556 |
| 4 | U | 13.84 | 36.14 | 56.81 | 15.00 | 1.7283 |
| **Gross Merch Vol** | | | | | | 12.4000 |

2.7a Calculate the biological volume. Calculate the stump volume and top volumes and then sum with the gross merchantable volume.

If the stump height <= 30 cm, then:

$$\frac{\text{Stump volume}}{(30\text{cm \& below})} = C * d_{30}^2 * (\text{stump height})$$

Where C = 0.00007854

$d_{30}$ = diameter at 30 cm

Stump volume = $(0.00007854)*(0.30)*(131.60)^2 = 0.4081\ m^3$

If the stump height is greater than 30 cm, then calculate the stump volume below 30 cm as shown above. Then, apply the appropriate log volume equation using the lower bound parameters (30 cm, $d_{30}$) and the upper bound parameters (stump height, diameter at stump height).

2.7b Calculate the top volume

Apply the same log volume equation as used in the merchantable log calculation. The lower parameters of merch. height and top diameter of 15cm and the upper bound parameters of total height and 0.0cm would be used. The section length would continue in 10cm segments until the top of the tree was reached.

The top log length is 41.0 - 36.14 = 4.86 m. The total volume of the tip would be 0.0266 m3.

Step 3 Determine the biological and gross merchantable volume.

Apply net downs. Cruiser estimated net factors by log for decay volume, cruiser called Z grades for waste volume, CGNF lookup table for breakage volume, and NVAF corrections from CGNF process.

For a list of the terms used in the following calculations see *Chapter 3, step 3*.

For the net down example, log # 3 will be used:

H grade, NF = 90%, Gross vol = 4.6556m3.

3.1 For each log, calculate the log breakage volume. Use the CGNF breakage % table by species, and maturity. The NVAF process did not include breakage volume, therefore, the breakage volume must be taken out before the remainder of the volume is adjusted. See

*Appendix 3* for the CGNF breakage table.

$B_i = V_i \times Fb$

Breakage volume = 4.6556 * 7% = 0.3259 $m^3$

Calculate log gross volume minus breakage.

$VmB_i = V_i(1 - Fb)$

The breakage factor for Yellow Cedar is 7%.

Gross volume minus breakage = Gross volume * (1-7%)

= 4.6556 * (93%)

= 4.3297 $m^3$

3.3 Apply the taper correction factor. The taper correction is used to correct the known bias in the gross volume of taper equations. These factors are corrected by species, maturity and live/dead. See *Appendix 4* for the NVAF adjustment table.

$VmBc_i = VmB_i \times Ft$

The taper adjustment factor for live Yellow Cedar is: 1.050

Gross Volume minus breakage after taper correction

= Gross volume minus breakage * taper correction factor.

= 4.3297 $m^3$ * 1.050

= 4.5462 $m^3$

3.4 Calculate the corrected gross volume.

$Vc_i = VmBc_i + B_i$

Gross volume after correction

= Gross Volume minus breakage after taper correction + breakage volume

= 4.5462 $m^3$ + 0.3259 $m^3$

= 4.8720 $m^3$

3.5 Calculate the tree decay factor. Take the average of all the log's net factors weighted by the sum of each log's gross volume minus breakage after taper correction calculated in step 3.3 above.

$$Fd = \frac{\sum_{i=1}^{n}(Fd_i \times VmBc_i)}{\sum_{i=1}^{n} VmBc_i}$$

= (100%*1.0801)+(100%*4.7943)+(90%*4.5462)+(88.3%*1.6876)/ 12.1082 $m^3$

= 11.45613 $m^3$ / 12.1082 $m^3$

= 94.6%

3.6 Correct the tree decay factor using the NVAF coefficients

$$Fdc = Fr \times Fd^{Fp}$$

Fr = NVAF correction ratio = 0.954 for live Yellow Cedar

Fp = NVAF correction power = 1.270 for live Yellow Cedar

NVAF corrections are found in *Appendix 4.*

NVAF corrected Net factor

= NVAF correction ratio * tree decay factor$^{\text{NVAR correction}}$

= 0.954 * 94.6% $^{1.270}$

= 88.9%

3.7 Calculate the adjusted decay factor by the NVAF factor. This is the net corrected volume for all logs except Z grade logs. For Z grade logs, the $VmBDc_i$ is the waste volume.

$$VmBDc_i = VmBc_i \times Fd_i \times \frac{Fdc}{Fd}$$

Gross vol corrected minus breakage and decay volume =

Gross vol corrected minus breakage volume * NF%log3 * correction

Decay factor/ cruiser's estimate of net %

= 4.5462 $m^3$ * 90% * 88.9% / 94.6%

= 3.8454 $m^3$ –

3.8 Calculate the decay volume

$$D_i = VmBc_i \times (1 - (Fd_i \times \frac{Fdc}{Fd}))$$

Decay corrected volume = Gross vol corrected minus breakage vol *

(1- (NF% log3 * corr Decay factor / cruiser's estimate of net %))

= 4.5462 m3 * (1 – (90% * 88.9%/ 94.6%)

= 4.5462 m3 * (0.1542)

= 0.7008 $m^3$

Note: Data as presented has been rounded for summary purposes. The final value is calculated based on the full intermediate significant figures (see Appendix 16 of the *Cruise Compilation Manual*).

3.9 Calculate the waste volume. (Only logs in the tree with "Z" grade)

$Vw_i = VmBDc_i$

$Vn_i = 0$

otherwise:

$Vw_i = 0$

$Vn_i = VmBDc_i$

If the log is a Z grade, the VmBDc = waste volume.

If the log is any grade except N or Z then the VmBDc = net volume. Note that N contributes to the decay/missing wood volume and Z contributes to the waste component.

3.10 Calculate the net volume. (Gross volume corrected – DWB volumes)

$$Vn = \sum_{i=1}^{n} Vn_i$$

Note – the volumes in these tables are are summed for all trees and reported as a percentage of the total volume by species, coniferous and all species.

| Log Position | Grade | Length (m) | Gross Volume ($m^3$) | Gross Volume Corr. ($m^3$) | Decay Volume Corr. ($m^3$) | Waste Volume Corr. ($m^3$) | Breakage Volume Uncorr. ($m^3$) | Net Volume Corr. ($m^3$) |
|---|---|---|---|---|---|---|---|---|
| 1 | Z | 1 | 1.1061 | 1.1575 | 0.0650 | 1.0151 | 0.0774 | 0.0000 |
| 2 | D | 8 | 4.9096 | 5.1379 | 0.2884 | | 0.3437 | 4.5058 |
| 3 | H | 13 | 4.6556 | 4.8720 | 0.7008 | | 0.3259 | 3.8454 |
| 4 | U | 13.84 | 1.7283 | 1.8086 | 0.2874 | | 0.1210 | 1.4002 |
| Totals | | 35.84 | 12.3996 | 12.9761 | 1.3416 | 1.0151 | 0.8680 | 9.7515 |

**Example 2**: Specifically designed for trees that contain N grade logs (missing sections in a tree).

The tree parameters are:

| | |
|---|---|
| **Species:** | **Douglas-fir** |
| DBH: | 89.6 cm |
| Total height: | 36.9 m |
| F.I.Z. | C |
| Stump height: | 30 cm |
| Top diameter: | 15.0 cm |
| Maturity: | Mature |
| Live/Dead: | Dead |

The log parameters are (as recorded by the cruiser):

| Log # | Grade | Log Length (m) | Net Factor (%) |
|---|---|---|---|
| 1 | N* | 1 | 00 |
| 2 | H | 8 | 95 |
| 3 | I | 7 | 98 |
| 4 | N* | 3 | 00 |
| 5 | U | 11 | 89 |
| 6 | N* | 99** | 00 |

* an N grade indicates that the log is missing and therefore, no volume is present. The N grade can be any log length as shown in this example.

** a 99 log length instructs the compiler program to extend the length of the last log up to the merch height of the tree (to the utilization limit).

Douglas-fir taper parameters for FIZs A, B and C are:

Step 1 Look up the appropriate regression coefficients, $a_1$, $a_2$,, $a_8$ and the inflection point, $p$. These parameters are dependent on species and Forest Inventory Zone. They are provided in the tables in the back of this Appendix.

$p$ = 0.25

$a_1$ = 1.012675

$a_2$ = 0.899136

$a_3$ = 1.000123

$a_4$ = 0.968978

$a_5$ = -0.190913

$a_6$ = 0.825961

$a_7$ = 0.048766

$a_8$ = -0.426214

Step 2 Determine the biological and gross merchantable volume.

2.1 Calculate the diameter inside bark at stump height using the Taper equation. Substitute the stump height for $h_i$ (if the resultant diameter is less than the specified top diameter, return 0 volume).

$d_{30}$ = 86.54 cm

2.2 Calculate the merchantable height of the tree.

Merchantable height = 32.57m

2.3 Calculate the length of the last log. Use this calculation even when a cruiser calls a length for the top log instead of 99.

Last log = merch. Height – (sum of log lengths) – stump height

Last log

= 32.57 - (8+1+7+3+11) - 0.30

= 2.57 - 0.30

= 2.27 m for last log of grade N

If the last log is less than the minimum log length for the species and grade, then append it to the second to last log.

For this example, since the last log is longer than the minimum log length of 0.0m for N grade Douglas-fir, the last log remains the last log.

There remains 6 merchantable logs for this tree.

2.4 Calculate the new net factor for the last log ONLY if the last log is combined with the second to last log.

Since the last logs remains as the last log, this step is not required.

2.5 Calculate the top diameter of each merchantable log using the taper equation.

| Log # | Grade | Log len (m) | Top Diameter |
|---|---|---|---|
| 1 | N | 1 | 73.11 |
| 2 | H | 8 | 58.22 |
| 3 | I | 7 | 50.71 |
| 4 | N | 1 | 46.42 |
| 5 | U | 11 | 21.77 |
| 6 | N | 2.27 | 15.00 |

2.6 Calculate the volume of the log using Smalian's volume equation, using 10cm segments.

Gross Merch volume of a Single Log - Use the taper equation to determine the 10 diameters for log # 1- grade N, 1m length.

| Position | $h_i$ | $d_i$ - taper equation | Area ($m^2$) | Gross Volume ($m^3$) |
|---|---|---|---|---|
| **stump** | 0.3 m | 86.54 cm | 0.5881 | - |
| **1** | 0.4 m | 83.72 cm | 0.5505 | 0.0569 |
| **2** | 0.5 m | 81.59 cm | 0.5228 | 0.0537 |
| **3** | 0.6 m | 79.88 cm | 0.5012 | 0.0512 |
| **4** | 0.7 m | 78.47 cm | 0.4836 | 0.0492 |
| **5** | 0.8 m | 77.27 cm | 0.4689 | 0.0476 |
| **6** | 0.9 m | 76.23 cm | 0.4564 | 0.0463 |
| **7** | 1.0 m | 75.32 cm | 0.4456 | 0.0451 |
| **8** | 1.1 m | 74.51 cm | 0.4360 | 0.0441 |
| **9** | 1.2 m | 73.77 cm | 0.4275 | 0.0432 |
| **10** | 1.3 m | 73.11 cm | 0.4198 | 0.0424 |

Volume of Log # 1: sum each 10cm segment of the log for volume = 0.4796 $m^3$.

Summary of volume by log:

| Log Position | Grade | Length (m) | hi (m) | Butt Dia (cm) | Top Dia (cm) | Gross Volume ($m^3$) |
|---|---|---|---|---|---|---|
| **1** | N* | 1 | 1.3 | 86.54 | 73.11 | 0.4796 |
| **2** | H | 8 | 9.3 | 73.11 | 58.22 | 2.5357 |
| **3** | I | 7 | 16.3 | 58.22 | 50.71 | 1.6449 |
| **4** | N* | 3 | 19.3 | 50.71 | 46.42 | 0.5578 |
| **5** | U | 11 | 30.3 | 46.42 | 21.77 | 1.1214 |
| **6** | N* | 2.27 | 32.57 | 21.77 | 15.00 | 0.0612 |
| **Gross Merch Vol** | | | | | | 6.4007 |

* N grade logs are portions missing from the tree. CGNF procedures do not separate the procedures for calculating missing wood and decay volume. Logs with missing wood (scars, mechanical damage), catfaces with missing wood, and logs with large hollow boles are net factored. Net factoring, technically is a process that removes decay volume from the gross volume of the log. In order to be consistent with this process, N grade logs' gross merchantable volume will be reported as full gross merchantable volume. A net factor of zero will be assigned to these logs so that net volume is zero. The procedure for dealing with missing wood versus decay volume may be reviewed in the future.

2.7a Calculate the biological volume. Calculate the stump volume and top volumes and then sum with the gross merchantable volume.

Stump volume = $(0.00007854)*(0.30)*(86.54)^2 = 0.1764\ m^3$

2.7b Calculate the top volume

Apply the same log volume equation as used in the merchantable log calculation. The lower parameters of merch. height and top diameter

of 15cm and the upper bound parameters of total height and 0.0cm would be used. The section length would continue in 10cm segments until the top of the tree was reached.

The top log length is 36.9 – 32.57 = 4.33 m. The total volume of the tip would be 0.0291 $m^3$.

Step 3 Apply net downs. Cruiser estimated net factors by log for decay volume, cruiser called Z grades for waste volume, CGNF lookup table for breakage volume, and NVAF corrections from CGNF process.

For a list of the terms used in the following calculations see Chapter 3, step 3.

For the net down example, log # 4 will be used:

N grade, NF = 00%, Gross vol = 0.5578 $m^3$.

3.1 For each log, calculate the log breakage volume. Use the CGNF breakage % table by species, and maturity. The NVAF process did not include breakage volume, therefore, the breakage volume must be taken out before the remainder of the volume is adjusted. See *Appendix 3* for the CGNF breakage table.

$$B_i = V_i \times Fb$$

Breakage volume = 0.5578 * 5% = 0.0279 $m^3$

3.2 Calculate log gross volume minus breakage.

$$VmB_i = V_i(1 - Fb)$$

The breakage factor for Douglas-fir is 5%.

Gross volume minus breakage = Gross volume * (1-5%)

= 0.5578 * (95%)

= 0.5299 $m^3$

3.3 Apply the taper correction factor. The taper correction is used to correct the known bias in the gross volume of taper equations. These factors are corrected by species, maturity and live/dead. See Appendix 4 for the NVAF adjustment table.

$$VmBc_i = VmB_i \times Ft$$

The Taper adjustment factor for dead Douglas-fir is: 0.855

Gross Volume minus breakage after taper correction.

= Gross volume minus breakage * taper correction

factor.

= 0.5299 m3 * 0.855

= 0.4531 $m^3$

3.4 Calculate the corrected gross volume.

$Vc_i = VmBc_i + B_i$

Gross volume after correction.

= Gross Volume minus breakage after taper correction + breakage volume

= 0.4531 m3 + 0.0279 $m^3$

= 0.4810 $m^3$

3.5 Calculate the tree decay factor. Take the average of all the log's net factors weighted by each log's gross volume minus breakage after taper correction calculated in step 3.3 above.

$$Fd = \frac{\sum_{i=1}^{n} (Fd_i \times VmBc_i)}{\sum_{i=1}^{n} VmBc_i}$$

(0%*0.3896)+(95%*2.0596)+(98%*1.3361)+(0%*0.4531)/ 5.1990 $m^3$

= 4.0767 $m^3$ / 5.1990 $m^3$

= 78.4%

3.6 Correct the tree decay factor using the NVAF coefficients.

$Fdc = Fr \times Fd^{Fp}$

Fr = NVAF correction ratio = 0.860 for dead Douglas-fir.

Fp = NVAF correction power = 1.000 for dead Douglas-fir.

NVAF corrections are found in Appendix 4.

NVAF corrected Net factor.

= NVAF correction ratio * tree decay factor$^{\text{NVAR correction}}$

= 0.860 * 78.4% $^{1.000}$

= 67.4%

3.7 Calculate the adjusted decay factor by the NVAF factor. This is the

net corrected volume for all logs except Z grade logs. For Z grade logs, the $VmBDc_i$ is the waste volume.

$$VmBDc_i = VmBc_i \times Fd_i \times \frac{Fdc}{Fd}$$

Gross vol corrected minus breakage and decay volume =.

Gross vol corrected minus breakage volume * NF%log4 * corrected.

Decay factor/ cruiser's estimate of net %.

= 0.4531 $m^3$ * 0% * 67.4% / 78.4%.

= 0.0000 $m^3$

3.8 Calculate the decay volume:

$$D_i = VmBc_i \times (1 - (Fd_i \times \frac{Fdc}{Fd}))$$

Decay corrected volume = Gross vol corrected minus brk vol *

(1- (NF% log4 * corr Decay factor / cruiser's estimate of net %))

= 0.4531 $m^3$ * (1 – (0% * 67.4%/ 78.4%**)**

= 0.4531 $m^3$ * (1.0000)

= 0.4531 $m^3$

Note: Data has been rounded for summary purposes. The final value is calculated based on intermediate significant figures (see Appendix 16 of the *Cruise Compilation Manual*).

3.9 Calculate the waste volume. (Only logs in the tree with "Z" grade).

Since log 4 is an N grade, there is no waste volume from log 4.

$Vw_i = VmBDc_i$

$Vn_i = 0$

otherwise:

$Vw_i = 0$

$Vn_i = VmBDc_i$

If the log is a Z grade, the VmBDc = waste volume.

If the log is any other grade, except N then the VmBDc = net volume.

3.10 Calculate the net volume (gross volume corrected – DWB volumes).

$$Vn = \sum_{i=1}^{n} Vn_i$$

| Log Position | Grade | Length (m) | Gross Volume ($m^3$) | Gross Volume Corr. ($m^3$) | Decay Volume Corr. ($m^3$) | Waste Volume Corr. ($m^3$) | Breakage Volume Uncorr. ($m^3$) | Net Volume Corr. ($m^3$) |
|---|---|---|---|---|---|---|---|---|
| 1 | N | 1 | 0.4796 | 0.4136 | 0.3896 | | 0.0240 | 0.0000 |
| 2 | H | 8 | 2.5357 | 2.1864 | 0.3789 | | 0.1268 | 1.6827 |
| 3 | I | 7 | 1.6449 | 1.4183 | 0.2100 | | 0.0822 | 1.1260 |
| 4 | N | 3 | 0.5578 | 0.4180 | 0.4531 | | 0.0279 | 0.0000 |
| 5 | U | 11 | 1.1214 | 0.9669 | 0.2137 | | 0.0561 | 0.6972 |
| 6 | N | 2.27 | 0.0612 | 0.0528 | 0.0497 | | 0.0031 | 0.0000 |
| Totals | | 32.27 | 6.4007 | 5.4560 | 1.6950 | | 0.3201 | 3.5059 |

# Appendix 2 Log Grade Validations

Please see Section 2.2.3 for examples of errors and warnings associated with the tables in Appendix 2.

**Douglas-fir** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| F | B | 5 | 60 | 9999 | 80 |
| F | C | 5 | 38 | 9999 | 80 |
| F | D | 5 | 76 | 9999 | 75 |
| F | F | 5 | 60 | 9999 | 75 |
| F | H | 5 | 38 | 50 | 75 |
| F | H | 5 | 50 | 9999 | 50 |
| F | I | 5 | 38 | 50 | 75 |
| F | I | 5 | 50 | 9999 | 50 |
| F | J | 5 | 15 | 38 | 75 |
| F | U | 5 | 38 | 9999 | 50 |
| F | U | 5 | 15 | 38 | 67 |
| F | U | 5 | 10 | 15 | 75 |
| F | X | 5 | 10 | 9999 | 33 |
| F | Y | 3 | 10 | 9999 | 10 |
| F | N | 1 | 10 | 9999 | 0 |
| F | Z | 1 | 10 | 9999 | 0 |

**Cedar** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| C | D | 5 | 60 | 120 | 75 |
| C | D | 5 | 120 | 9999 | 67 |
| C | F | 5 | 50 | 9999 | 75 |
| C | H | 5 | 38 | 9999 | 75 |
| C | I | 5 | 38 | 50 | 75 |
| C | I | 10 | 50 | 9999 | 50 |
| C | K | 4 | 50 | 9999 | 50 |
| C | L | 4 | 38 | 9999 | 50 |
| C | M | 4 | 38 | 9999 | 50 |
| C | J | 5 | 15 | 38 | 75 |
| C | U | 5 | 38 | 9999 | 50 |
| C | U | 5 | 15 | 38 | 67 |
| C | U | 5 | 10 | 15 | 75 |
| C | X | 5 | 10 | 9999 | 33 |
| C | Y | 3 | 10 | 9999 | 10 |
| C | N | 1 | 10 | 9999 | 0 |
| C | Z | 1 | 10 | 9999 | 0 |

**Hemlock** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| H | D | 5 | 66 | 9999 | 75 |
| H | F | 5 | 50 | 9999 | 75 |
| H | H | 5 | 38 | 9999 | 75 |
| H | I | 5 | 38 | 9999 | 50 |
| H | J | 5 | 15 | 38 | 75 |
| H | U | 5 | 38 | 9999 | 50 |
| H | U | 5 | 15 | 38 | 67 |
| H | U | 5 | 10 | 15 | 75 |
| H | X | 5 | 10 | 9999 | 33 |
| H | Y | 3 | 10 | 9999 | 10 |
| H | N | 1 | 10 | 9999 | 0 |
| H | Z | 1 | 10 | 9999 | 0 |

**Balsam** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| B | D | 5 | 66 | 9999 | 75 |
| B | F | 5 | 50 | 9999 | 75 |
| B | H | 5 | 38 | 9999 | 75 |
| B | I | 5 | 38 | 9999 | 50 |
| B | J | 5 | 15 | 38 | 75 |
| B | U | 5 | 38 | 9999 | 50 |
| B | U | 5 | 15 | 38 | 67 |
| B | U | 5 | 10 | 15 | 75 |
| B | X | 5 | 10 | 9999 | 33 |
| B | Y | 3 | 10 | 9999 | 10 |
| B | N | 1 | 10 | 9999 | 0 |
| B | Z | 1 | 10 | 9999 | 0 |

**Spruce** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| S | F | 5 | 76 | 9999 | 75 |
| S | G | 5 | 60 | 9999 | 75 |
| S | H | 5 | 38 | 9999 | 75 |
| S | H | 5 | 60 | 50 | 50 |
| S | I | 5 | 38 | 50 | 75 |
| S | I | 5 | 50 | 9999 | 50 |
| S | J | 5 | 15 | 38 | 75 |
| S | U | 5 | 38 | 9999 | 50 |
| S | U | 5 | 15 | 38 | 67 |
| S | U | 5 | 10 | 15 | 75 |
| S | X | 5 | 10 | 9999 | 33 |
| S | Y | 3 | 10 | 9999 | 10 |
| S | N | 1 | 10 | 9999 | 0 |
| S | Z | 1 | 10 | 9999 | 0 |

**Cypress** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| CY | D | 5 | 60 | 9999 | 75 |
| CY | F | 5 | 50 | 9999 | 75 |
| CY | H | 5 | 38 | 9999 | 50 |
| CY | I | 5 | 38 | 9999 | 50 |
| CY | J | 5 | 15 | 38 | 75 |
| CY | U | 5 | 38 | 9999 | 50 |
| CY | U | 5 | 15 | 38 | 67 |
| CY | U | 5 | 10 | 15 | 75 |
| CY | X | 5 | 10 | 9999 | 33 |
| CY | Y | 3 | 10 | 9999 | 10 |
| CY | N | 1 | 10 | 9999 | 0 |
| CY | Z | 1 | 10 | 9999 | 0 |

**White Pine** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| PW | D | 5 | 76 | 9999 | 75 |
| PW | F | 5 | 60 | 9999 | 75 |
| PW | H | 5 | 38 | 9999 | 75 |
| PW | H | 5 | 50 | 9999 | 50 |
| PW | I | 5 | 38 | 50 | 75 |
| PW | I | 5 | 50 | 9999 | 50 |
| PW | J | 5 | 15 | 38 | 75 |
| PW | U | 5 | 38 | 9999 | 50 |
| PW | U | 5 | 15 | 38 | 67 |
| PW | U | 5 | 10 | 15 | 75 |
| PW | X | 5 | 10 | 9999 | 33 |
| PW | Y | 3 | 10 | 9999 | 10 |
| PW | N | 1 | 10 | 9999 | 0 |
| PW | Z | 1 | 10 | 9999 | 0 |

**Lodgepole Pine** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| PL | D | 5 | 76 | 9999 | 75 |
| PL | F | 5 | 60 | 9999 | 75 |
| PL | H | 5 | 38 | 50 | 75 |
| PL | H | 5 | 50 | 9999 | 50 |
| PL | I | 5 | 38 | 50 | 75 |
| PL | I | 5 | 50 | 9999 | 50 |
| PL | J | 5 | 15 | 38 | 75 |
| PL | U | 5 | 38 | 9999 | 50 |
| PL | U | 5 | 15 | 38 | 67 |
| PL | U | 5 | 10 | 15 | 75 |
| PL | X | 5 | 10 | 9999 | 33 |
| PL | Y | 3 | 10 | 9999 | 10 |
| PL | N | 1 | 10 | 9999 | 0 |
| PL | Z | 1 | 10 | 9999 | 0 |

**Ponderosa Pine** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| PY | D | 5 | 76 | 9999 | 75 |
| PY | F | 5 | 60 | 9999 | 75 |
| PY | H | 5 | 38 | 50 | 75 |
| PY | H | 5 | 50 | 9999 | 50 |
| PY | I | 5 | 38 | 50 | 75 |
| PY | I | 5 | 50 | 9999 | 50 |
| PY | J | 5 | 15 | 38 | 75 |
| PY | U | 5 | 38 | 9999 | 50 |
| PY | U | 5 | 15 | 38 | 67 |
| PY | U | 5 | 10 | 15 | 75 |
| PY | X | 5 | 10 | 9999 | 33 |
| PY | Y | 3 | 10 | 9999 | 10 |
| PY | N | 1 | 10 | 9999 | 0 |
| PY | Z | 1 | 10 | 9999 | 0 |

**Larch** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| L | D | 5 | 76 | 9999 | 75 |
| L | F | 5 | 60 | 9999 | 75 |
| L | H | 5 | 38 | 50 | 75 |
| L | H | 5 | 50 | 9999 | 50 |
| L | I | 5 | 38 | 50 | 75 |
| L | I | 5 | 50 | 9999 | 50 |
| L | J | 5 | 15 | 38 | 75 |
| L | U | 5 | 38 | 9999 | 50 |
| L | U | 5 | 15 | 38 | 67 |
| L | U | 5 | 10 | 15 | 75 |
| L | X | 5 | 10 | 9999 | 33 |
| L | Y | 3 | 10 | 9999 | 10 |
| L | N | 1 | 10 | 9999 | 0 |
| L | Z | 1 | 10 | 9999 | 0 |

**Cottonwood** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| AC | C | 5 | 25 | 9999 | 80 |
| AC | I | 5 | 25 | 9999 | 50 |
| AC | U | 5 | 25 | 9999 | 50 |
| AC | U | 5 | 15 | 25 | 67 |
| AC | U | 5 | 10 | 15 | 75 |
| AC | Y | 3 | 10 | 9999 | 10 |
| AC | N | 1 | 10 | 9999 | 0 |
| AC | Z | 1 | 10 | 9999 | 0 |

**Alder** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| D | I | 5 | 25 | 9999 | 50 |
| D | U | 5 | 25 | 9999 | 50 |
| D | U | 5 | 15 | 25 | 67 |
| D | U | 5 | 10 | 15 | 75 |
| D | Y | 3 | 10 | 9999 | 10 |
| D | N | 1 | 10 | 9999 | 0 |
| D | Z | 1 | 10 | 9999 | 0 |

**Maple** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| MB | I | 5 | 25 | 9999 | 50 |
| MB | U | 5 | 25 | 9999 | 50 |
| MB | U | 5 | 15 | 25 | 67 |
| MB | U | 5 | 10 | 15 | 75 |
| MB | Y | 3 | 10 | 9999 | 10 |
| MB | N | 1 | 10 | 9999 | 0 |
| MB | Z | 1 | 10 | 9999 | 0 |

**Birch** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| E | I | 5 | 25 | 9999 | 50 |
| E | U | 5 | 25 | 9999 | 50 |
| E | U | 5 | 15 | 25 | 67 |
| E | U | 5 | 10 | 15 | 75 |
| E | Y | 3 | 10 | 9999 | 10 |
| E | N | 1 | 10 | 9999 | 0 |
| E | Z | 1 | 10 | 9999 | 0 |

**Aspen** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| AT | I | 5 | 25 | 9999 | 50 |
| AT | U | 5 | 25 | 9999 | 50 |
| AT | U | 5 | 15 | 25 | 67 |
| AT | U | 5 | 10 | 15 | 75 |
| AT | Y | 3 | 10 | 9999 | 10 |
| AT | N | 1 | 10 | 9999 | 0 |
| AT | Z | 1 | 10 | 9999 | 0 |

**Whitebark Pine** (except heli-log = 4m):

| Species | Grade | Min Log Len (m) | Min Top Dia (cm) | Max Top Dia (cm) | Min Net Factor (%) |
|---|---|---|---|---|---|
| PA | D | 5 | 76 | 9999 | 75 |
| PA | F | 5 | 60 | 9999 | 75 |
| PA | H | 5 | 38 | 50 | 75 |
| PA | H | 5 | 50 | 9999 | 50 |
| PA | I | 5 | 38 | 50 | 75 |
| PA | I | 5 | 50 | 9999 | 50 |
| PA | J | 5 | 15 | 38 | 75 |
| PA | U | 5 | 38 | 9999 | 50 |
| PA | U | 5 | 15 | 38 | 67 |
| PA | U | 5 | 10 | 15 | 75 |
| PA | X | 3 | 10 | 9999 | 33 |
| PA | Y | 3 | 10 | 9999 | 10 |
| PA | N | 1 | 10 | 9999 | 0 |
| PA | Z | 1 | 10 | 9999 | 0 |

# Appendix 3 CGNF Breakage Table

These breakage factors are to be used for CGNF compilations only.

| Species | Maturity | % |
|---|---|---|
| All conifers | Second Growth | 2% |
| All deciduous | Second Growth | 4% |
| Pl, Py | Mature | 2% |
| L | Mature | 4% |
| F, S, Pw, Pa | Mature | 5% |
| H, B | Mature | 5.5% |
| Cw, Yc | Mature | 7% |
| All deciduous | Mature | 5% |

# Appendix 4 Net Volume Adjustment factors (NVAF)

| Species | Live/Dead | Age Class | Taper Ratio | NVAF Ratio | NVAF Power |
|---|---|---|---|---|---|
| F | D | ALL | 0.855 | 0.86 | 1 |
| F | L | 2nd Growth | 1.006 | 1 | 1 |
| F | L | MAT | 0.964 | 0.976 | 1.296 |
| C | D | ALL | 0.998 | 0.956 | 1 |
| C | L | 2nd Growth | 0.998 | 0.981 | 1 |
| C | L | MAT | 1.078 | 0.994 | 1.085 |
| HW | D | ALL | 0.855 | 0.86 | 1 |
| HW | L | 2nd Growth | 1.019 | 0.998 | 1 |
| HW | L | MAT | 0.988 | 0.947 | 0.844 |
| B | D | ALL | 0.855 | 0.86 | 1 |
| B | L | 2nd Growth | 0.967 | 1 | 1 |
| B | L | MAT | 0.998 | 0.93 | 1 |
| S | D | ALL | 0.855 | 0.86 | 1 |
| S | L | 2nd Growth | 1.015 | 0.997 | 1 |
| S | L | MAT | 1 | 1 | 1 |
| CY | D | ALL | 0.998 | 0.956 | 1 |
| CY | L | ALL | 1.05 | 0.954 | 1.27 |
| PW | D | ALL | 0.855 | 0.86 | 1 |
| PW | L | ALL | 1 | 1 | 1 |
| PL | D | ALL | 0.855 | 0.86 | 1 |
| PL | L | ALL | 1 | 1 | 1 |
| PY | D | ALL | 0.855 | 0.86 | 1 |

| Species | Live/Dead | Age Class | Taper Ratio | NVAF Ratio | NVAF Power |
|---|---|---|---|---|---|
| PY | L | ALL | 1 | 1 | 1 |
| L | D | ALL | 0.855 | 0.86 | 1 |
| L | L | ALL | 1 | 1 | 1 |
| AC | D | ALL | 0.855 | 0.86 | 1 |
| AC | L | ALL | 1 | 1 | 1 |
| D | D | ALL | 0.855 | 0.86 | 1 |
| D | L | ALL | 0.967 | 1 | 1 |
| MB | D | ALL | 0.855 | 0.86 | 1 |
| MB | L | ALL | 1 | 1 | 1 |
| E | D | ALL | 0.855 | 0.86 | 1 |
| E | L | ALL | 1 | 1 | 1 |
| AT | D | ALL | 0.855 | 0.86 | 1 |
| AT | L | ALL | 1 | 1 | 1 |
| PA | D | ALL | 0.855 | 0.86 | 1 |
| PA | L | ALL | 1 | 1 | 1 |
| HM | D | ALL | 0.855 | 0.86 | 1 |
| HM | L | 2nd Growth | 0.984 | 1 | 1 |
| HM | L | MAT | 0.9 | 0.945 | 1 |

# Appendix 5 Spruce High Grade Table

**Percentages within Spruce Grades**

| Natural Resource District | G | F |
|---|---|---|
| | E | D |
| Campbell River | **90** | **89** |
| | 10 | 11 |
| Chilliwack | **100** | **0** |
| | 0 | 0 |
| South Island | **65** | **84** |
| | 35 | 16 |
| Coast Mountain | **74** | **72** |
| | 26 | 28 |
| North Island - Central Coast | **73** | **51** |
| | 27 | 49 |
| Haida Gwaii | **74** | **34** |
| | 26 | 66 |
| Sea to Sky | **100** | **0** |
| | 0 | 0 |
| Sunshine Coast | **100** | **0** |
| | 0 | 0 |

Source of the table is the Coast Grade Distribution Report *2015-04-01 to 2017-03-31.*

**Example:**

In the South Island District when a log is recorded as G, 65% of the log net volume will be deemed to be G grade and 35% will be deemed to be E grade. Similarly, when a log is recorded as an F grade, 84% will be F grade and 16% will be D grade.

**Note:**

In Chilliwack, Sea to Sky and Sunshine Coast Districts, a log recorded as E, F or D will default to 100% G grade. This is due to little or no historical scale data for E, F or D grades in these districts.

# Appendix 6 Taper Coefficients for BC Commercial Species

**Inflection Points**

p

| Species | F.I.Z. A, B & C | F.I.Z. D - J | F.I.Z. K & L |
|---|---|---|---|
| F | 0.25 | 0.25 | 0.25 |
| C | 0.25 | 0.30 | 0.30 |
| H | 0.20 | 0.25 | 0.25 |
| B | 0.25 | 0.30 | 0.30 |
| S | 0.25 | 0.30 | 0.30 |
| Y | 0.30 | 0.30 | 0.30 |
| PW | 0.25 | 0.25 | 0.25 |
| PL | 0.25 | 0.25 | 0.25 |
| PY | 0.25 | 0.25 | 0.25 |
| L | 0.30 | 0.30 | 0.30 |
| AC | 0.25 | 0.25 | 0.25 |
| D | 0.30 | 0.30 | 0.30 |
| MB | 0.25 | 0.25 | 0.25 |
| E | 0.25 | 0.25 | 0.25 |
| AT | 0.20 | 0.20 | 0.20 |
| PA | 0.25 | 0.25 | 0.25 |

**Regression Coefficients**

$a_1$

| Species | F.I.Z. A, B & C | F.I.Z. D - J | F.I.Z. K & L |
|---|---|---|---|
| F | 1.012675 | 0.920840 | 0.920840 |
| C | 1.218296 | 1.033575 | 1.033575 |
| H | 0.830874 | 0.752027 | 0.752027 |
| B | 0.988964 | 1.008741 | 0.764353 |
| S | 0.924126 | 0.897311 | 0.897595 |
| Y | 0.928138 | 0.928138 | 0.928138 |
| PW | 0.868943 | 0.984019 | 0.984019 |
| PL | 0.774601 | 0.774601 | 0.793793 |
| PY | 0.856592 | 0.856592 | 0.856592 |
| L | 0.746827 | 0.746827 | 1.164819 |
| AC | 0.802839 | 0.802839 | 0.852579 |
| D | 0.718188 | 0.718188 | 0.718188 |
| MB | 0.802839 | 0.802839 | 0.852579 |
| E | 0.648830 | 0.648830 | 0.633306 |
| AT | 0.855966 | 0.855966 | 0.891641 |
| PA | 1.078961 | 1.078961 | 1.078961 |

$a_2$

| Species | F.I.Z. A, B & C | F.I.Z. D - J | F.I.Z. K & L |
|---|---|---|---|
| F | 0.899136 | 0.923867 | 0.923867 |
| C | 0.855983 | 0.896971 | 0.896971 |
| H | 1.005210 | 1.028970 | 1.028970 |
| B | 0.951803 | 0.916357 | 1.053220 |
| S | 0.950707 | 0.957090 | 0.957499 |
| Y | 0.945293 | 0.945293 | 0.945293 |
| PW | 0.976312 | 0.941322 | 0.941322 |
| PL | 1.040320 | 1.040320 | 1.049320 |
| PY | 0.936402 | 0.936402 | 0.936402 |
| L | 1.003900 | 1.003900 | 0.831995 |
| AC | 0.993776 | 0.993776 | 0.952969 |
| D | 1.052190 | 1.052190 | 1.052190 |
| MB | 0.993776 | 0.993776 | 0.952969 |
| E | 1.121390 | 1.121390 | 1.110510 |
| AT | 0.987014 | 0.987014 | 0.957835 |
| PA | 0.894083 | 0.894083 | 0.894083 |

$a_3$

| Species | F.I.Z. A, B & C | F.I.Z. D - J | F.I.Z. K & L |
|---|---|---|---|
| F | 1.000123 | 1.000568 | 1.000568 |
| C | 0.999921 | 0.999079 | 0.999079 |
| H | 0.999142 | 0.998660 | 0.998660 |
| B | 0.999789 | 1.001159 | 0.994711 |
| S | 0.999518 | 0.999370 | 0.998952 |
| Y | 0.999206 | 0.999206 | 0.999206 |
| PW | 0.999773 | 0.999700 | 0.999700 |
| PL | 0.996984 | 0.996984 | 0.995709 |
| PY | 1.002104 | 1.002104 | 1.002104 |
| L | 0.997233 | 0.997233 | 1.003909 |
| AC | 0.998974 | 0.998974 | 1.000477 |
| D | 0.997551 | 0.997551 | 0.997551 |
| MB | 0.998974 | 0.998974 | 1.000477 |
| E | 0.992077 | 0.992077 | 0.994733 |
| AT | 0.999828 | 0.999828 | 1.001450 |
| PA | 1.001749 | 1.001749 | 1.001749 |

$a_4$

| Species | F.I.Z. A, B & C | F.I.Z. D - J | F.I.Z. K & L |
|---|---|---|---|
| F | 0.968978 | 1.095560 | 1.095560 |
| C | 2.037620 | 1.598260 | 1.598260 |
| H | 1.770670 | 1.174800 | 1.174800 |
| B | 2.336270 | 1.415990 | 1.381630 |
| S | 1.750510 | 1.532270 | 1.110150 |
| Y | 0.301423 | 0.301423 | 0.301423 |
| PW | 1.676930 | 1.571030 | 1.571030 |
| PL | 0.745750 | 0.745750 | 0.583403 |
| PY | 0.566217 | 0.566217 | 0.566217 |
| L | 0.747048 | 0.747048 | 1.880250 |
| AC | 0.706093 | 0.706093 | 0.731911 |
| D | 0.599235 | 0.599235 | 0.599235 |
| MB | 0.706093 | 0.706093 | 0.731911 |
| E | 0.865974 | 0.865974 | 1.021680 |
| AT | 0.424473 | 0.424473 | 0.695143 |
| PA | 1.377540 | 1.377540 | 1.377540 |

$a_5$

| Species | F.I.Z. A, B & C | F.I.Z. D - J | F.I.Z. K & L |
|---|---|---|---|
| F | -0.190913 | -0.202191 | -0.202191 |
| C | -0.486492 | -0.411541 | -0.411541 |
| H | -0.329190 | -0.263576 | -0.263576 |
| B | -0.502311 | -0.325671 | -0.306534 |
| S | -0.408021 | -0.364679 | -0.281544 |
| Y | -0.040792 | -0.040792 | -0.040792 |
| PW | -0.372195 | -0.369344 | -0.369344 |
| PL | -0.130177 | -0.130177 | -0.077654 |
| PY | -0.087141 | -0.087141 | -0.087141 |
| L | -0.133729 | -0.133729 | -0.401856 |
| AC | -0.096789 | -0.096789 | -0.084192 |
| D | -0.033036 | -0.033036 | -0.033036 |
| MB | -0.096789 | -0.096789 | -0.084192 |
| E | -0.106757 | -0.106757 | -0.141481 |
| AT | -0.037553 | -0.037553 | -0.039652 |
| PA | -0.286807 | -0.286807 | -0.286807 |

$a_6$

| Species | F.I.Z. A, B & C | F.I.Z. D - J | F.I.Z. K & L |
|---|---|---|---|
| F | 0.825961 | 0.967329 | 0.967329 |
| C | 2.632080 | 2.402420 | 2.402420 |
| H | 2.185610 | 2.233330 | 2.233330 |
| B | 4.154490 | 2.793270 | 2.637080 |
| S | 2.659000 | 2.741210 | 2.125100 |
| Y | -1.235630 | -1.235630 | -1.235630 |
| PW | 2.567510 | 2.703200 | 2.703200 |
| PL | 0.558818 | 0.558818 | -0.036267 |
| PY | -0.063450 | -0.063450 | -0.063450 |
| L | 0.397110 | 0.397110 | 3.082780 |
| AC | 0.312724 | 0.312724 | 0.196339 |
| D | -0.261339 | -0.261339 | -0.261339 |
| MB | 0.312724 | 0.312724 | 0.196339 |
| E | 0.257139 | 0.257139 | 0.641499 |
| AT | -0.517540 | -0.517540 | -0.603404 |
| PA | 1.038780 | 1.038780 | 1.038780 |

$a_7$

| Species | F.I.Z. A, B & C | F.I.Z. D - J | F.I.Z. K & L |
|---|---|---|---|
| F | 0.048766 | 0.081696 | 0.081696 |
| C | 0.109094 | 0.094283 | 0.094283 |
| H | 0.105050 | 0.045184 | 0.045184 |
| B | 0.086560 | 0.108427 | 0.163996 |
| S | 0.092651 | 0.117756 | 0.148340 |
| Y | 0.030743 | 0.030743 | 0.030743 |
| PW | 0.071928 | 0.049628 | 0.049628 |
| PL | 0.198687 | 0.198687 | 0.142531 |
| PY | 0.071720 | 0.071720 | 0.071720 |
| L | 0.078345 | 0.078345 | 0.276300 |
| AC | 0.119634 | 0.119634 | 0.148285 |
| D | 0.215536 | 0.215536 | 0.215536 |
| MB | 0.119634 | 0.119634 | 0.148285 |
| E | 0.254574 | 0.254574 | 0.258921 |
| AT | 0.102211 | 0.102211 | 0.193706 |
| PA | 0.072537 | 0.072537 | 0.072537 |

$a_8$

| Species | F.I.Z. A, B & C | F.I.Z. D - J | F.I.Z. K & L |
|---|---|---|---|
| F | -0.426214 | -0.514604 | -0.514604 |
| C | -1.486550 | -1.252170 | -1.252170 |
| H | -1.192970 | -1.002020 | -1.002020 |
| B | -2.186240 | -1.326790 | -1.292080 |
| S | -1.396760 | -1.362760 | -1.005560 |
| Y | 0.672879 | 0.672879 | 0.672879 |
| PW | -1.340830 | -1.334700 | -1.334700 |
| PL | -0.324178 | -0.324178 | -0.022523 |
| PY | 0.051415 | 0.051415 | 0.051415 |
| L | -0.183542 | -0.183542 | -1.661550 |
| AC | -0.080057 | -0.080057 | -0.069852 |
| D | 0.123059 | 0.123059 | 0.123059 |
| MB | -0.080057 | -0.080057 | -0.069852 |
| E | -0.149926 | -0.149926 | -0.359508 |
| AT | 0.303931 | 0.303931 | 0.209159 |
| PA | -0.647372 | -0.647372 | -0.647372 |

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