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Cubic Foot Volume Equations for the United States outside of California, Washington, Oregon, Alaska, and Hawaii

August 16, 2013

Instructions

The equations for calculating cubic foot volume by Supersection and species are provided below for all trees having a **dbh equal to or greater than 5 inches, excluding woodland species**.¹ Refer to the *Volume Equation References and Coefficients by Species for Supersections outside of California, Washington, Oregon, Alaska, and Hawaii* document table available on the website to determine which equations to use and to retrieve the appropriate coefficients by Supersection and species relevant to the project. If an equation is needed for a species that is not listed in your Supersection, contact the Reserve for guidance.

Adjust the resulting VOLCFGRS (gross cubic foot volume) to VOLCFSND (sound cubic foot volume) by subtracting rotten and missing cull volume in the central stem of each tree. Use VOLCFSND with Appendix J of the *FIA Database: Database Description and Users Manual* (FIADB Users Manual) which is titled *Biomass Estimation Using the Component Ratio Method* found on the [Forest Project Protocol Resources](#) webpage.

Trees with dbh less than 5 inches do not require cubic foot volume calculations to estimate biomass using the Component Ratio Method. Biomass for trees less than 5 inches in dbh is calculated using Appendix J of the FIA Database Users Manual with dbh only.

Update to September 2010 version: A typographical error in the Hann/Bare VOLCFGRS equations was corrected.

¹ Woodland tree species (identified in the table "Biomass Coefficients for use with the Component Ratio Method" with an "X" in the "Woodland" column) also do not require cubic foot volume calculations to estimate biomass. Biomass for woodland species is calculated using Appendix J with drc (diameter at the root collar).

Equations

The following equations compute cubic foot volume excluding bark from a 1 foot stump to a 4 inch top (VOLCFGRS).

East, RMRS program HARDTS.F, 2003.

RMRS program HARDTS.F, 2003. "REF_VOLCFGRS_VW" data base. Acquired from: Glenn Christensen, Resource Monitoring and Assessment/Forest Inventory and Analysis, USDA Forest Service, PNW Research Station, Portland Forest Sciences Laboratory. April 2010.

VOLCFGRS	=	Cubic foot volume for use with FIADB Users Manual, Appendix J, Tables 4 and 5
DBH	=	Diameter at breast height (inches)
THT	=	Total height
SPN	=	Species number
A_POLE_GCV, B_POLE_GCV	=	Coefficients for poles by species
A_SAW_GCV, B_SAW_GCV	=	Coefficients for saw logs by species

Poles:

DBH<9 AND SPN<300 OR DBH<11 AND SPN≥300

$$\text{VOLCFGRS} = \text{A_POLE_GCV}(\text{SPN}) + \text{B_POLE_GCV}(\text{SPN}) \times \text{DBH}^2 \times \text{THT}$$

Sawlogs:

$$\text{VOLCFGRS} = \text{A_SAW_GCV}(\text{SPN}) + \text{B_SAW_GCV}(\text{SPN}) \times \text{DBH}^2 \times \text{THT}$$

Edminster, C.B., H.T. Mowrer and T.E. Hinds, 1982.

Edminster, C.B., H.T. Mowrer and T.E. Hinds, 1982. Volume Tables and Point-Sampling Factors for Aspen in CO, Res. Note RM-232, USDA, Forest Service, RMRC, Fort Collins, CO.

VOLCFGRS	=	Cubic foot volume or VOLCFGRS (for use with FIADB Users Manual, Appendix J, Tables 4 and 5)
DBH	=	Diameter at breast height (inches)
THT	=	Total height

$$\text{D2H} = \text{DBH}^2 \times \text{THT}$$

D2H ≤ 11800:

$$\text{VOLCFGRS} = 0.002195 \times \text{D2H} - 0.9076$$

D2H > 11800:

$$\text{VOLCFGRS} = 0.001837 \times \text{D2H} + 3.3075$$

Edminster, C.B., R.T. Beeson and G.E. Metcalf, 1980.

Edminster, C.B., R.T. Beeson and G.E. Metcalf, 1980. Volume Tables and Point-Sampling Factors for Ponderosa Pine in the CO Front Range. Res. Note RM-218, USDA, Forest Service, RMRC, Fort Collins, CO.

VOLCFGRS = Cubic foot volume for use with FIADB Users Manual, Appendix J, Tables 4 and 5
DBH = Diameter at breast height (inches)
THT = Total height
SPN = Species number

$$\text{VOLCFGRS} = 0.00216 \times \text{DBH}^2 \times \text{THT} - 0.4467$$

Hann, D.W. and B.B. Bare, 1978. (2002)

Hann, D.W. and B.B. Bare, 1978. Comprehensive Tree Volume Equations for Major Species of NM and AZ: I. Results and Methodology. Res. Note INT-209, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIADB Users Manual, Appendix J, Tables 4 and 5
DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

$$\text{VOLCFGRS} = (0.438373815 + 0.00175642739 \times \text{DBH}^2 \times \text{THT}) - \text{TOPVOL}$$

Hann, D.W. and B.B. Bare, 1978. (2008)

Hann, D.W. and B.B. Bare, 1978. Comprehensive Tree Volume Equations for Major Species of NM and AZ: I. Results and Methodology. Res. Note INT-209, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIADB Users Manual, Appendix J, Tables 4 and 5
DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

DBH < 21:

$$\text{VOLCFGRS} = (0.0810724804 + 0.00198351037 \times \text{DBH}^2 \times \text{THT}) - \text{TOPVOL}$$

DBH ≥ 21:

$$\text{VOLCFGRS} = (0.237204154 + 0.00221122919 \times \text{DBH}^2 \times \text{THT}) - \text{TOPVOL}$$

Hann, D.W. and B.B. Bare, 1978. (2010)

Hann, D.W. and B.B. Bare, 1978. Comprehensive Tree Volume Equations for Major Species of NM and AZ: I. Results and Methodology. Res. Note INT-209, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIADB Users Manual, Appendix J, Tables 4 and 5
DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

DBH < 21:

$$\text{VOLCFGRS} = (0.0483082948 + 0.00204968419 \times \text{DBH}^2 \times \text{THT}) - \text{TOPVOL}$$

DBH ≥ 21:

$$\text{VOLCFGRS} = (0.237204154 + 0.00221122919 \times \text{DBH}^2 \times \text{THT}) - \text{TOPVOL}$$

Hann, D.W. and B.B. Bare, 1978. (3002)

Hann, D.W. and B.B. Bare, 1978. Comprehensive Tree Volume Equations for Major Species of NM and AZ: I. Results and Methodology. Res. Note INT-209, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIADB Users Manual, Appendix J, Tables 4 and 5
DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

$$\text{VOLCFGRS} = (0.160888987 + 0.00203250045 \times \text{DBH}^2 \times \text{THT}) - \text{TOPVOL}$$

Hann D.W. and B.B. Bare, 1978. (3004)

Hann, D.W. and B.B. Bare, 1978. Comprehensive Tree Volume Equations for Major Species of NM and AZ: I. Results and Methodology. Res. Note INT-209, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIADB Users Manual, Appendix J, Tables 4 and 5
DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

$$\text{VOLCFGRS} = (0.225466084 + 0.00216969983 \times \text{DBH}^2 \times \text{THT}) - \text{TOPVOL}$$

Hann D.W. and B.B. Bare, 1978. (5002)

Hann, D.W. and B.B. Bare, 1978. Comprehensive Tree Volume Equations for Major Species of NM and AZ: I. Results and Methodology. Res. Note INT-209, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIADB Users Manual, Appendix J, Tables 4 and 5
DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

$$\text{VOLCFGRS} = (0.210903832 + 0.00183995833 \times \text{DBH}^2 \times \text{THT}) - \text{TOPVOL}$$

Hann, D.W. and B.B. Bare, 1978. (6004)

Hann, D.W. and B.B. Bare, 1978. Comprehensive Tree Volume Equations for Major Species of NM and AZ: I. Results and Methodology. Res. Note INT-209, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIADB Users Manual, Appendix J, Tables 4 and 5
DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

$$\text{VOLCFGRS} = (0.0327 + 0.00231123522 \times \text{DBH}^2 \times \text{THT}) - \text{TOPVOL}$$

Hahn, Jerold T., 1984.

Hahn, Jerold T. Tree volume and biomass equations for the Lake States. Res. Pap. NC-250. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1984. 10 p.

VOLCFGRS = Cubic foot volume for use with FIADB Users Manual, Appendix J, Tables 4 and 5
DBH = Diameter at breast height (inches)
SI = Site index
A1-A4 = Coefficients by species
SPN = Species number

$$\text{VOLCFGRS} = \text{A1}(\text{SPN}) \times \text{SI}^{\text{A2}(\text{SPN})} \times (1 - \text{EXP}(\text{A3}(\text{SPN}) \times \text{DBH}^{\text{A4}(\text{SPN})}))$$

Kemp P.D., 1956.

Kemp P.D., 1956. Region I Volume Tables for ADP Cruise Computations. Timber Cruising Handbook, R1-2430-31.

VOLCFGRS = Cubic foot volume or VOLCFGRS (for use with FIADB Users Manual, Appendix J, Tables 4 and 5)
DBH = Diameter at breast height (inches)
D2H = $DBH^2 \times THT$
THT = Total height
C1S, C2S, CBP = Coefficients by species for small trees
C1L, C2L, CBP = Coefficients by species for large trees
SPN = Species Number

Hemlock: $CBP(SP_N)=0$

Small trees: $DBH < 21$

$$CU = C1S(SP_N) + C2S(SP_N) \times D2H$$

Large trees: $DBH \geq 21$

$$CU = C1L(SP_N) + C2L(SP_N) \times D2H$$

Other species:

Small trees: $D2H \leq CBP(SP_N)$

$$CU = C1S(SP_N) + C2S(SP_N) \times D2H$$

Large trees: $D2H \geq CBP(SP_N)$

$$CU = C1L(SP_N) + C2L(SP_N) \times D2H$$

McClure, J. and Cost, N., 2010.

McClure, J. and Cost, N. Unpublished equations developed by Joe McClure and Noel Cost. "REF_VOLCFGRS_VW" data base. Acquired from: Glenn Christensen, Resource Monitoring and Assessment/Forest Inventory and Analysis, USDA Forest Service, PNW Research Station, Portland Forest Sciences Laboratory. April 2010.

VOLCFGRS = Cubic foot volume or VOLCFGRS (for use with FIADB Users Manual, Appendix J, Tables 4 and 5)
DBH = Diameter at breast height (inches)
HT = Height (feet)
A1-D2 = Coefficients by species
SPN = Species number

Poles:

Conifer ($SP_N < 300$), $DBH \geq 5.0$ and < 9.0

Hardwood ($SP_N \geq 300$), $DBH \geq 5.0$ and < 11.0

$$VOLCFGRS = C1(SP_N) + C2(SP_N) \times DBH^2 \times HT$$

Saw timber:

Conifer ($SP_N < 300$), $DBH \geq 9.0$

Hardwood ($SP_N > 300$), $DBH \geq 11.0$

$$VOLCFGRS = D1(SP_N) + D2(SP_N) \times DBH^2 \times HT$$

Moisen, 1989.

Moisen, 1989. From unpublished memo dated October 4, 1989. "REF_VOLCFGRS_VW" data base. Acquired from: Glenn Christensen, Resource Monitoring and Assessment/Forest Inventory and Analysis, USDA Forest Service, PNW Research Station, Portland Forest Sciences Laboratory. April 2010.

A0,A1,A2 = Total volume coefficients
B0,B1,B2 = Diameter ratio coefficients
F = Bark factor

$$CU = A0 \times DBH^{A1} \times THT^{A2}$$
$$DIB_TOP = DOB(4) / F$$

$$VOLCFGRS = CU - (CU \times (B0 \times (DIB_TOP^{B1}/DBH^{B2})))$$

Myers, C.A., 1964. (8002)

Myers, C.A., 1964. Volume Table and Point Sampling Factors for Lodgepole Pine in CO and WY. Res. Note RM-6, USDA, Forest Service, RMRC, Fort Collins, CO.

VOLCFGRS = Cubic foot volume or VOLCFGRS (for use with FIADB Users Manual, Appendix J, Tables 4 and 5)
DBH = Diameter at breast height (inches)
THT = Total height
D2H = $DBH^2 \times THT$

D2H ≤ 7000:
$$VOLCFGRS = 0.002798 \times D2H - 1.04578$$

D2H > 7000:
$$VOLCFGRS = 0.002256 \times D2H + 2.836222$$

Myers, C.A., 1964. (2004)

Myers, C.A., 1964. Volume Tables and Point-Sampling Factors for Ponderosa Pine in the Black Hills. Res. Note RM-8, USDA, Forest Service, RMRC, Fort Collins, CO.

VOLCFGRS = Cubic foot volume or VOLCFGRS (for use with FIADB Users Manual, Appendix J, Tables 4 and 5)
DBH = Diameter at breast height (inches)
THT = Total height
D2H = $DBH^2 \times THT$

D2H ≤ 6700:
$$VOLCFGRS = 0.002297 \times D2H - 1.032297$$

D2H > 6700:
$$VOLCFGRS = 0.002407 \times D2H - 2.257724$$

Myers and Edminster, 1972.

Myers, C.A. and C.B. Edminster, 1972. Volume Table and Point Sampling Factors for Engelmann Spruce in CO and WY. Res. Note RM-95, USDA, Forest Service, RMRC, Fort Collins, CO.

VOLCFGRS = Cubic foot volume or VOLCFGRS (for use with FIADB Users Manual, Appendix J, Tables 4 and 5)
DBH = Diameter at breast height (inches)
THT = Total height
D2H = $DBH^2 \times THT$

D2H ≤ 27900:

$$VOLCFGRS = 0.00232 \times D2H - 0.83010$$

D2H > 27900:

$$VOLCFGRS = 0.00182 \times D2H + 13.11320$$

Scott, Charles T., 1981.

Scott, Charles T., Gross cubic foot volume from 1 foot stump to 4 inch top. Northeastern Forest Survey Revised Cubic-Foot Volume Equations. Research Note NE-304, 1981.

VOLCFGRS = Cubic foot volume or VOLCFGRS (for use with FIADB Users Manual, Appendix J, Tables 4 and 5)
DBH = Diameter at breast height (inches)
BOLEHT = Height at a 4 inch top (feet)
A1-A6 = Coefficients by species
SPN = Species number

$$VOLCFGRS = A1(SPN) + A2(SPN) \times DBH^{A3(SPN)} + A4(SPN) \times DBH^{A5(SPN)} \times BOLEHT^{A6(SPN)}$$