Cubic Foot Volume Equations for the United States Outside of California, Oregon, and Washington

Instructions:

The equations for calculating cubic foot volume by Supersection and species are provided below for all trees having a **diameter at breast height (dbh) equal to or greater than 5 inches, excluding woodland species**[1]. Refer to the Volume Equation References and Coefficients by Supersection 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 ARB or an Approved Offset Registry for guidance.

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

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 with dbh only.

[1] Woodland tree species (identified in the table "Biomass Coefficients for Jenkins (REF_SPECIES for Appendix J)" 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 FIA Database Description and 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

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

Sawlogs:

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

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 FIA Database Description and Users Manual, Appendix J, Tables 4 and 5)
DBH = Diameter at Breast Height (inches)
THT = Total height
$D2H = DBH^2 \times THT$

D2H <= 11800:

$$VOLCFGRS = 0.002195 \times D2H - 0.9076$$

D2H > 11800:

$$VOLCFGRS = 0.001837 \times D2H + 3.3075$$

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 FIA Database Description and Users Manual, Appendix J, Tables 4 and 5.
DBH = Diameter at Breast Height (inches)
THT = Total Height
SPN = Species Number

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

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, Intermountatin Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIA Database Description and 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)

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

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, Intermountatin Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIA Database Description and 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:

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

DBH >=21:

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

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, Intermountatin Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIA Database Description and 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:

VOLCFGRS = ((0.0483082948 + 0.00204968419) x DBH^2 x THT) – TOPVOL

DBH >=21:

VOLCFGRS = ((0.237204154 + 0.00221122919) x DBH^2 x THT) – 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, Intermountatin Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIA Database Description and 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)

VOLCFGRS = ((0.160888987+.00203250045) x DBH^2 x THT) – 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, Intermountatin Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIA Database Description and 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)

VOLCFGRS = ((0.225466084 + 0.00216969983) x DBH^2 x THT) – 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, Intermountatin Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIA Database Description and 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)

$VOLCFGRS = ((.210903832+.00183995833) \times DBH^2 \times THT) - TOPVOL$

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, Intermountatin Res. Station, Ogden, UT 84401.

VOLCFGRS = Cubic foot volume for use with FIA Database Description and 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)

$VOLCFGRS = ((.0327+.00231123522) \times DBH^2 \times THT) - TOPVOL$

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 FIA Database Description and 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

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

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 FIA Database Description and Users Manual, Appendix J, Tables 4 and 5)
DBH = Diameter at Breast Height (inches)
D2H = DBH^2xTHT
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(SPN)=0

Small trees: DBH<21

CU = C1S(SPN) + C2S(SPN)xD2H

Large trees: DBH>=21

CU = C1L(SPN) + C2L(SPN)xD2H

Other species:

Small trees: D2H<=CBP(SPN)

CU = C1S(SPN) + C2S(SPN)xD2H

Large trees: D2H>=CBP(SPN)

CU = C1L(SPN) + C2L(SPN)xD2H

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 FIA Database Description and 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 (SPN<300), DBH>=5.0 and < 9.0
Hardwood (SPN>=300), DBH>=5.0 and < 11.0
VOLCFGRS = C1(SPN) + C2(SPN) x DBH^2 x HT

Saw timber:

Conifer (SPN<300), DBH>=9.0
Hardwood (SPN>300), DBH>=11.0
VOLCFGRS = D1(SPN) + D2(SPN) x DBH^2 x 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 FIA Database Description and 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 x D2H – 1.04578

D2H > 7000:
VOLCFGRS = 0.002256 x 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 FIA Database Description and 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 x D2H – 1.032297

D2H > 6700:
VOLCFGRS = 0.002407 x 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 FIA Database Description and Users Manual, Appendix J, Tables 4 and 5)
DBH = Diameter at Breast Height (inches)
THT = Total height
$D2H = DBH^2 x THT$

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 FIA Database Description and 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

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