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. 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.

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).


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(SP)N + B_POLE_GCV(SP)N x DBH^2 x THT

Sawlogs:
VOLCFGRS = A_SAW_GCV(SP)N + B_SAW_GCV(SP)N x DBH^2 x THT


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 <= 11800:
VOLCFGRS = 0.002195 x D2H – 0.9076

D2H > 11800:
VOLCFGRS = 0.001837 x D2H + 3.3075

DBH = Diameter at Breast Height (inches)
THT = Total Height
SPN = Species Number

VOLCFGRS = 0.00216 x DBH² x THT – 0.4467


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) x DBH² x THT) – TOPVOL


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) x DBH² x THT) – TOPVOL

DBH >= 21:
VOLCFGRS = ((0.237204154 + 0.00221122919) x DBH² x THT) – TOPVOL

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 = \((0.0483082948 + 0.00204968419) \times DBH^2 \times THT\) – TOPVOL

DBH >= 21:
  VOLCFGRS = \((0.237204154 + 0.00221122919) \times DBH^2 \times THT\) – TOPVOL

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

DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

VOLCFGRS = \((0.160888987+.00203250045) \times DBH^2 \times THT\) – TOPVOL

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

DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

VOLCFGRS = \((0.225466084 + 0.00216969983) \times DBH^2 \times THT\) – TOPVOL
Hann, D.W. and B.B. Bare, 1978. (5002)

DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

\[\text{VOLCFGRS} = (\cdot210903832+\cdot00183995833 \times DBH^2 \times THT) - \text{TOPVOL}\]

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

DBH = Diameter at breast height (inches)
THT = Total height
TOPVOL = Cubic foot volume of a 4 inch top (user provides tip equations)

\[\text{VOLCFGRS} = (\cdot0327+.00231123522 \times DBH^2 \times THT) - \text{TOPVOL}\]

Hahn, Jerold T., 1984

DBH = Diameter at breast height (inches)
SI = Site index
A1-A4 = Coefficients by species
SPN = Species number

\[\text{VOLCFGRS} = A1(\text{SPN}) \times SI^{A2(\text{SPN})} \times (1 - \exp(A3(\text{SPN}) \times DBH^{A4(\text{SPN})}))\]
Kemp P.D., 1956.

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^2 x 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(SPN)=0
  Small trees: DBH<21
    CU = C1S(SPN) + C2S(SPN) x D2H
  Large trees: DBH>=21
    CU = C1L(SPN) + C2L(SPN) x D2H

Other species:
  Small trees: D2H<=CBP(SPN)
    CU = C1S(SPN) + C2S(SPN) x D2H
  Large trees: D2H>=CBP(SPN)
    CU = C1L(SPN) + C2L(SPN) x D2H

McClure, J. and Cost, N. 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

A0,A1,A2 = Total Volume Coefficients
B0,B1,B2 = Diameter Ratio Coefficients
F = Bark factor

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

VOLCFGRS = CU - (CU x (B0 x (DIB_TOP^{B1}/DBH^{B2}))

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

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 * THT

D2H <= 7000:
VOLCFGRS = 0.002798 x D2H – 1.04578

D2H > 7000:
VOLCFGRS = 0.002256 x D2H + 2.836222


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 * THT

D2H <= 6700:
VOLCFGRS = 0.002297 x D2H – 1.032297

D2H > 6700:
VOLCFGRS = 0.002407 x D2H - 2.257724
Myers and Edminster, 1972

\[\text{VOLCFGRS} = \text{Cubic foot volume or VOLCFGRS (for use with FIA Database Description and Users Manual, Appendix J, Tables 4 and 5)}\]

\[\text{DBH} = \text{Diameter at Breast Height (inches)}\]

\[\text{THT} = \text{Total height}\]

\[\text{D2H} = \text{DBH}^2 \times \text{THT}\]

\[\text{D2H} \leq 27900:\]
\[\text{VOLCFGRS} = 0.00232 \times \text{D2H} - 0.83010\]

\[\text{D2H} > 27900:\]
\[\text{VOLCFGRS} = 0.00182 \times \text{D2H} + 13.11320\]

Scott, Charles T., 1981

\[\text{VOLCFGRS} = \text{Cubic foot volume or VOLCFGRS (for use with FIA Database Description and Users Manual, Appendix J, Tables 4 and 5)}\]

\[\text{DBH} = \text{Diameter at breast height (inches)}\]

\[\text{BOLEHT} = \text{Height at a 4 inch top (feet)}\]

\[\text{A1–A6} = \text{Coefficients by species}\]

\[\text{SPN} = \text{Species number}\]

\[\text{VOLCFGRS} = \text{A1(SPН)} + \text{A2(SPН)} \times \text{DBH}^{\text{A3(SPН)}} + \text{A4(SPН)} \times \text{DBH}^{\text{A5(SPН)}} \times \text{BOLEHT}^{\text{A6(SPН)}}\]