# ALLOMTERIC BIOMASS EQUATIONS

14 Species and 2 General

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Biomass equation are developed as a part of National Forest Inventory of Bhutan NFI. Two equations each using DBH only (basal area) and DBH and Height (BAH) are developed for fourteen species, one common equation for conifers and one common equation for broadleaved species. Following are the list of biomass equations

### A. List of biomass equations with Basal Area (DBH) as predictor variable

| Species | No. of samples | Min. DBH (cm) | Maximum DBH (cm) | Equation | t1 | t2 | t3 |
|---|---|---|---|---|---|---|---|
| Abies densa | 55 | 5 | 82 | -5.76+3436.38*ba +36408.9*X2 | 0.004562 | 0.110447 | 0.303648 |
| Cupressus corneyana | 32 | 3.6 | 88 | -3.96+4300*ba+ 50295*X2 | 0.003905 | 0.098999 | 0.37853 |
| Juniperus recurva | 32 | 6 | 68 | -4.85+3234*ba+ 26753*X2 | 0.006816 | 0.075555 | 0.263935 |
| Larix griffithii | 32 | 5.2 | 83 | -3.84+3455*ba+ 29738*X2 | 0.008396 | 0.131148 | 0.330317 |
| Picea spinulosa | 48 | 5.6 | 87 | -6.164+3934*ba+ 43569*X2 | 0.006648 | 0.113411 | 0.321234 |
| Pinus roxburghii | 51 | 3 | 77.8 | -3.44+5098*ba+ 56376*X2 | 0.0023 | 0.1029 | 0.368529 |
| Pinus wallichiana | 52 | 2.6 | 95.8 | -1.57+3444*ba+ 55392*X2 | 0.00309 | 0.098407 | 0.394911 |
| Tsuga dumosa | 55 | 4.5 | 95 | -4.8+3854*ba+ 15174*X2 | 0.006181 | 0.138544 | 0.440845 |
| Castanopsis tribulnoides | 32 | 5 | 89 | 1.39+5303*ba+2722X2+4129*X3 | 0.007382 | 0.134038 | 0.40222 |
| Quercus glauca | 34 | 4.2 | 77.3 | -3.97+6437*ba+ 36970*X2 | 0.006536 | 0.099043 | 0.374257 |
| Quercus griffithii | 32 | 8 | 79.5 | -9.38+5438*ba+ 15835*X2 | 0.00731 | 0.132139 | 0.364998 |
| Quercus lanata | 34 | 3.3 | 77.5 | -0.77+4500*ba+ 25308*X2 | 0.013335 | 0.141882 | 0.393956 |
| Rhododendron arboreum | 35 | 5.5 | 58.4 | -0.19+1637*ba+ 43190*X2 | 0.006834 | 0.091863 | 0.207339 |
| Alnus nepalensis | 32 | 7 | 77 | -12.3+5474*ba+ 1581*X2 | 0.008812 | 0.131185 | 0.415138 |
| General conifer | 357 | 2.6 | 95.8 | -12.3+3299*ba+ 52756*X2 | 0.004927 | 0.107521 | 0.369822 |
| General broadleaf | 199 | 3.3 | 89 | -1.06+4341*ba+ 30173X2+4013*X3 | 0.006648 | 0.119459 | 0.368977 |

B. **List of biomass equations with Basal Area (DBH) and Height as predictor variable**

| Species | No. of samples | Minimum DBH (cm) | Maximum DBH (cm) | Equation | t1 | t2 | t3 |
|---|---|---|---|---|---|---|---|
| Abies densa | 55 | 5 | 82 | 2.35313+173.7675*bah-0.59995*X2 | 0.023989 | 2.572786 | 10.73243 |
| Cupressus corneyana | 32 | 3.6 | 88 | 1.22235+165.16238*bah-0.31452*X2 | 0.024764 | 3.498551 | 17.51606 |
| Juniperus recurva | 32 | 6 | 68 | 4.08057+201.65385*bah-2.18485*X2 | 0.059807 | 1.436454 | 5.571413 |
| Larix griffithii | 32 | 5.2 | 83 | 2.73648+221.68872*bah-1.618*X2 | 0.069668 | 2.894957 | 11.17016 |
| Picea spinulosa | 48 | 5.6 | 87 | 5.539+179.124*bah+-0.396*X2 | 0.045708 | 2.588578 | 12.01843 |
| Pinus roxburghii | 51 | 3 | 77.8 | 0.93085+286.67503*bah-0.939*X2 | 0.013202 | 2.678307 | 14.03231 |
| Pinus wallichiana | 52 | 2.6 | 95.8 | 0.63608+195.88699*bah-0.6393*X2 | 0.02457 | 2.424196 | 14.68175 |
| Tsuga dumosa | 55 | 4.5 | 95 | 2.80713+181.04279*bah-0.47106*X2 | 0.056836 | 3.518025 | 15.82663 |
| Castanopsis tribulnoides | 32 | 5 | 89 | 13.01+297*bah+-2.34X2+3849*X3 | 0.046199 | 2.517564 | 10.00328 |
| Quercus glauca | 34 | 4.2 | 77.3 | 2.73+423*bah-4.22*X2 | 0.049256 | 1.704485 | 10.86179 |
| Quercus griffithii | 32 | 8 | 79.5 | 9.85+261.6*bah-101*X2 | 0.07945 | 2.914077 | 9.398556 |
| Quercus lanata | 34 | 3.3 | 77.5 | 2.22+341*bah-1.92*X2 | 0.120915 | 2.224379 | 7.623232 |
| Rhododendron arboreum | 35 | 5.5 | 58.4 | 1.87+214*bah-1.38*X2 | 0.035309 | 0.90026 | 2.678036 |
| Alnus nepalensis | 32 | 7 | 77 | 15.1+194*bah-0.44*X2 | 0.112019 | 3.992085 | 14.19324 |
| General conifer | 358 | 2.6 | 95.8 | 1.1209+201.92169*bah-0.76344*X2 | 0.028401 | 2.601966 | 13.99573 |
| General broadleaf | 200 | 2.6 | 95.8 | 4.11+302*bah+-2.78X2+3697*X3 | 0.055951 | 1.770287 | 10.10082 |

Note:

Biomass is in kilogram

ba = Basal area ($m^2$)

h = height (m)

The $X_2$ is spline function of ba or bah as follows:

$$X_2 = \mathrm{g(x)} = (x - t1)_+^3 - (x - t2)_+^3 \frac{(t3 - t1)}{(t3 - t2)} + (x - t3)_+^3 \frac{(t2 - t1)}{(t3 - t2)}$$

and the value of the each component of equation is computed using the knot values with equation

$(x - t1)_+^3$ = $(X - t1)_+^3$, if x> t1 and $(x - t1)_+^3$=0, if x<t1

$$(x - t2)_+^3 = (X - t2)_+^3, if\ x > t2, and\ (x - t2)_+^3 = 0, if\ x < t2$$

$(x - t3)_+^3$= $(X - t3)_+^3$, if x > t3, and $(x - t3)_+^3$=0, if x<t3

$t_1$, $t_2$ and $t_3$ for the above models are 10th, 50th and 90th percentiles of *ba or bah* called knots.

x= ba or bah