BSORT

BSORT is a model developed by Forest Research to provide estimates of forest biomass (Matthews and Duckworth, 2005). It is based on allometric equations derived from data collected following the destructive sampling of individual trees of different species and size classes and is consequently designed to give tree-level estimates of biomass for the major components (root, stump, merchantable stem to top diameter 7 cm over bark, stem tip, branches and foliage). Although originally calibrated for individual trees, BSORT can be used to generate stand level estimates of biomass from estimates of mean diameter at breast height[1] (DBH) and number of trees. Both of these input variables are available from SCDB and NFI data.

BSORT uses the stand-level values of mean DBH and number of trees to subdivide each Forecast component into a number of DBH classes, as suggested by the stand and stock tables appropriate to the management regime being applied. For each diameter class within the diameter distribution applied to the Forecast component, BSORT calculates a mean DBH and number of stems. It is these values that are used as the basis for biomass estimation.

The allometric equations used to predict crown and root biomass in the original version of BSORT were largely derived from existing scientific literature (McKay *et al.*, 2003). Most of these equations followed a general exponential form and were driven by DBH and/or total height as input variables. The form of these equations meant that they did not extrapolate well when applied to larger-dimension trees, producing overestimates of crown and root biomass in trees larger than the biggest that had been used for model calibration. A new set of 'crown' and 'root' biomass equations have therefore been specifically developed for use within the version of BSORT linked to the Forecast System. These updated biomass models have been constrained[2] to reduce the likelihood of overestimating the biomass of larger trees (>30 cm dbh for estimates of root biomass and >50 cm dbh for estimates of crown biomass). Further details of the modelling approach are given in Randle *et al.* (2013).

---

[1] The mean diameter at breast is calculated as the square root of the mean of the sum of squared diameters at breast height. This is equivalent to the diameter of the tree of mean basal area.

[2] It is important to note that, because of a lack of biomass data for larger diameter trees, the effect of these constraints cannot currently be quantified.

The current version of BSORT produces estimates of biomass for three major parts of the “average” tree in each diameter class present in each Forecast component. These parts are:

- the tree crown (incorporating the stem tip, branches, twigs and foliage);
- the merchantable stem to top diameter 7 cm over bark; and
- the roots (comprising both coarse and fine roots, and the tree stump).

Both crown and root biomass models within the Forecast System use the mean DBH of each diameter class within the Forecast component as the single input variable and directly output biomass as oven-dry tonnes. The biomass of the merchantable stem is derived by multiplying the merchantable volume (m^3) of the tree of mean DBH in each diameter class by the relevant species-specific nominal specific gravity (NSG) of the timber from Lavers and Moore (1983). Further information on this procedure can be found in Section 5 of Jenkins *et al*. (2014).

The estimates of crown, stem and root biomass are summed to give the biomass contained within the ‘average’ tree within each diameter class. The biomass of each ‘average’ tree is then multiplied by the number of trees in the same diameter class to give the total biomass for all trees contained within that diameter class. The values for all diameter classes within the Forecast component are finally summed to give an estimate of the total tree biomass for that component.

Key assumptions

The key assumptions underlying the figures biomass forecast are:

1. that information contained in the SCDB is correct and that NFI sampling is unbiased;
2. that the theoretical diameter distributions generated by BSORT are, on average, representative of the actual diameter distributions present across the Forecast area;
3. that the tree of mean dbh is truly representative of the “average” biomass tree for each part of the diameter distribution in each Forecast component;
4. that the diameter distribution is not unusual;
5. that the numbers of tree stems have been correctly recorded for each forecast component;
6. that multiplying the number of tree stems by the biomass contained in the tree of mean DBH will give a good approximation of total biomass within each part of the diameter distribution in each Forecast component;
7. that deciduous trees are in leaf;

8. that the revised biomass equations (and associated calibration and species mapping) are an unbiased and reasonable reflection of the relationships between dbh and crown and root biomass; and
9. that uncertainty around the estimates generated via the above equations, although not quantified is small.

References

Jenkins, T.A.R, Mackie, E.D., Matthews, R.W., Miller, G., Randle, T.J. and White, M. E. (2014 *FC woodland carbon code: carbon assessment protocol*. Forestry Commission: Edinburgh. Copies can be found on the woodland biomass code website at www.forestry.gov.uk/carboncode

Matthews, R.W. and Duckworth, R.R. (2005). *BSORT: a Model of Tree and Stand Biomass Development and Production in Great Britain.* In: Imbabi, M.S. and Mitchell, C.P. (eds.) *Proceedings of World Renewable Energy Congress (WREC 2005), 22-27 May 2005, Aberdeen, UK.* Elsevier: Oxford, pp. 404-409.

McKay, H., Hudson, J.B. and Hudson, R.J. (2003). *Woodfuel Resource in Britain: Appendices.* FES B/W3/00787/REP/2. DTI/Pub URN 03/1436. Forestry Contracting Association.