Use of bisection method in the redwood growth model

The bisection method is used in the redwood growth model for calculating Δt_{thin} following a thinning, and for estimating D_{30} from a plot measurement. This simple root-finding algorithm can be used for solving $f(x) = 0$ for a continuous function f with solution known to lie in the interval $[a, b]$. If the required precision of x is $\pm P$, the number of iterations required to guarantee this precision is $N = log_2(|b-a|/P)$. The algorithm is as follows:

Repeat the following three steps N times:

1. Calculate $c = (a+b)/2$,
2. Calculate $f(a)$, $f(b)$, and $f(c)$,
3. If $f(a) \times f(c) < 0$ then $b = c$, else $a = c$

After N iterations, the final solution is $x = c$.

Calculation of Δt_{thin}

The bisection method is used to calculate t', the value of t_{BH} for which Equation (18) predicts D_q to equal D_2, the DBH immediately following thinning. The method is applied by setting $a = 0.1$ and $b = t_{BH} + 1$ with $f(t_{BH}) = D_2 - D_q$, where $\underline{D}_q$ is calculated using Equation (18). Once t' is estimated using this procedure, Δt_{thin} is calculated using $\Delta t_{\text{thin}} = t' - t_{\text{thin}}$. Eleven iterations guarantee a precision for the solution of Δt_{thin} of better than ±0.05 years.

Calculation of D_{30}

The bisection method is used to calculate D_{30} from a plot measurement D_0 of D_q. Measurement age, stand density and SI for the plot must also be known along with any known thinning history. The method is applied by setting $a = 1$ and $b = 100$, with $f(t_{BH}) = D_0 - D_q$, where $\underline{D}_q$ is calculated using Equation (18).

If the plot has been thinned prior to measurement, D_{30} is firstly estimated using the bisection method with Δt_{thin} set to 0. Equation (18) is then used to predict the D_q immediately before thinning, D_1, and Equation (6) used to estimate D_q following thinning, D_2. The value of Δt_{thin} can then be estimated using the bisection method as outlined above. The bisection method is then used to estimate D_{30} using Δt_{thin}. This procedure is repeated several times until a stable estimate of D_{30} is obtained.