

Future Forests Research - Cypress Calculator

Introduction

The Future Forests Research (FFR) Cypress Calculator is a web-based (online) tool for stand growth modelling and management of Cypress plantations in New Zealand. The main purpose of the Cypress Calculator is to deliver scientific growth model information for Cypress species to foresters in an easy-to-use and easy-accessible way, and at the same time double as a simple stand management tool for Cypress plantations. The present document describes in general terms how to use the system. The Cypress Calculator employs the mathematical models developed by Berrill, P. (2004).

The system is accessed through a web-browser using the url: <http://cypresscalc.ffr.co.nz> - The Cypress Calculator supports most newer browsers, including Internet Explorer, Firefox, Safari, and Chrome. The only technical requirement is that Javascript is enabled in the browser. If you experience any problems (e.g. javascript-errors, overlapping content, strange formatting) please upgrade your browser to the newest version. To identify individual users it is a requirement that you log on to the system – you can get your own personal login information through FFR.

Overall

Once you are logged in, the main screen of the Cypress Calculator consist of two areas:

- 1) Top menu (at the top)
- 2) Main (everything else)

The top menu is present at all times, and consists of a logo to the left, three menu items (*Calculator*, *Stand manager* and *Settings*), and then your name and a "log off"-button to the right. The contents of the "Main part" of the screen depends on which item from the menu is active (indicated with bold font and shaded background) - default is *Calculator*. You can always jump from one menu item to another using your mouse.

The *Calculator* allows you to explore the growth model by modelling a 1ha stand. The *Stand manager* enables you to manage/model a set of actual/hypothetical stands via the growth model. The *Settings* enables you to change some basic settings for your account.

The *Calculator* and the *Stand manager* are highly integrated. When you have specified a stand in the *Calculator*, you may save the stand in the *Stand manager*. Similarly, you may open any stand from the *Stand manager* in the *Calculator*.

Online help items are available in some places. Look for green dots with a white exclamation mark inside them - a help text is shown when you hover the mouse-pointer above these dots.

Work-flow

When you log on to the system the *Calculator* will show your default stand. The default stand is a "play-stand", where you can alter conditions and explore the growth model without changes to the stands in your *Stand manager*. You can always return to your "play-stand": Go to the *Stand manager* and push the "Start new stand"-button in the upper right-hand corner (the button is only available if the default stand is not already active).

Once you have specified a stand in the *Calculator* and want to store it in the *Stand manager*, then go to the *Stand information* tab in the *Calculator* and give the stand a name (so you are able to identify it later on). You do this by filling out the identification information, e.g. any combination of forest, compartment, stand, and substand. Once you have identified your stand and saved that

information (push "Save information"-button), a "Save stand in manager"-button appears in the lower right corner. When you push this button the stand is saved, and you are transferred to the *Stand manager*, where you will see a list of all your stands - including the newly saved stand (marked by blue background = active stand).

If you return to the *Calculator* (using the top menu) you will see that the name of the stand you just saved is shown in bold on green background above the tabs. When-ever there is a stand name above the tabs in the *Calculator* this is your active stand - any changes/alterations you make in the *Calculator* will be saved to this stand.

In the *Stand manager* the active stand is highlighted by a blue background in the stand list. You can always return to your default "play-stand": Go to the *Stand manager* and push the "Start new stand"-button in the upper right hand corner.

The Calculator

When you click on the *Calculator* menu item (default) the "main part" of the screen is divided into two panes. On the left you have a beige box with *Growth model information*, on the right you have a set of tabs (*Stand tabs*) with various stand information.

Growth model information

You can customise your stand by changing the numbers in the *Growth model information*. The first part contains the most basic information:

- 1) Species (macrocarpa, lusitanica)
- 2) Site index
- 3) Rotation age (any number between 20 and 100)
- 4) Report intervals (any number between 1-10)

There are three ways to set Site Index (which drives height growth): a) let the calculator estimate it from starting conditions, b) set it manually (default), or c) let the calculator estimate it from one or more measurements. To use option a) check the radio-button next to the "Start MTH" label and input your starting mean top height. To use option b) check the radio-button next to Site Index and input your Site Index. To use option c) input one or more height measurements in the measurements-tab (if there are more than one measurement an average site index is estimated).

Please note that report interval does not change how the model works - only how the growth information is shown in the *Stand growth* tab.

The second part of the *Growth model information* is a tool to estimate the conditions at stand age 5 years. This tool is used when you have no available growth data except the stocking at planting and a fair indication of growth potential at your site. Input stocking at planting and expected site quality, and push the button "Predict age 5 start" to estimate the stand conditions at age 5. The estimated starting conditions are automatically input into the third part of *Growth model information*.

The third part contains the starting conditions for the growth model. If you have your own information (age, stocking, height etc) for example from sample plots, you can input these instead of using aforementioned "Predict age 5 start" routine. You can start the growth model at any age you want - all fields are required; age, stocking, basal area and mean top height.

The fourth and final part of the *Growth model information* is used for specifying thinnings (if any). Input the age at which the thinning takes place, how many stems are left after the thinning, and the thinning coefficient. The thinning coefficient is essentially the ratio between the basal area of the trees thinned and those left behind, e.g. a thinning coefficient of 0.75 (<1) indicates that the trees thinned are smaller than those left behind (thinning-from-below). Coefficients larger than 1 are

indicative of thinning-from-above. See Berrill (2004) for more information on the thinning coefficient. Once a thinning is specified click the "Add"-button and the thinning will be added to the *Growth model information* and the growth is automatically recalculated. There is no technical limit to the number of thinnings. Delete a thinning by clicking the "Delete"-button next to it in the list of thinnings.

The settings in the *Growth model information* section of the screen will affect how the growth is modelled. Once you change them you may need to hit the "Calculate"-button at the bottom for the changes to take effect. Please note that when you hit "Calculate" the information is also saved on the server. Likewise when you add thinnings or predict starting conditions the system is automatically recalculated and conditions saved.

Stand tabs

In the right pane of the main screen in the *Calculator* is a set of tabs:

- 1) Stand information
- 2) Stand growth
- 3) Stand graphs
- 4) Economics
- 5) Measurements

The *Stand information* tab holds specific and detailed stand information, such as identification information, time of planting, area, altitude and description. You can edit these by clicking on the individual fields and change their contents. When you have finished editing, push the "Save stand information"-button (at the bottom) to save the data. In the upper right hand corner are two icons. The print icon opens a new window with all stand information (tabs) in a print-ready format. The globe icon opens a new window with the map-feature. This feature employs Google Maps to locate/position the stand in the physical world. There are two tools on the map: a) Hand tool, which allows you to pan and zoom, b) Polygon tool, which allows you to draw an outline of the stand. Once you have panned/zoomed to your stands position and perhaps outlined it, push the "Save"-button to store the information. Please note that when you use the stand-outline draw-routine an automatic area-calculation is performed – this calculation will override any information input manually in the *area* field in the *Stand information* tab. You may subsequently change/adjust the area manually if required.

The *Stand growth* tab holds a model/projection of the stands life by listing stocking, mean diameter, mean top height, basal area, volume and carbon throughout the stands life (until rotation age). The table also shows cut volume as well as mean DBH of thinnings. Total standing volume is converted to carbon using a general conversion factor of 0.21 tC/m³ - i.e. an average specific gravity (density) of 420 kg/m³ with an average C-content of 50%. Please note that this carbon measure does not take other sources than standing volume into account (e.g. leaves and branches, below-ground biomass etc.). The individual variables are reported annually or as specified in the *Growth model information* pane on the left, or when something special happens (thinning, measurement or clear-fell). Thinnings are shown/outlined in light-green and measurements in blue. For years with thinnings and measurements, both before and after values are shown. If you have specified a planting year for the stand (in the *Stand information* tab) the time (year) of each annual step is also shown.

The *Stand graphs* tab holds a graphical representation of the information in the *Stand growth* tab. Four graphs are shown: Stocking, mean top height, basal area and stand volume - all plotted against stand age (years).

The *Economics* tab contains economic projections along with stand conditions at expected rotation

age, and a graph of NPV (sum of discounted cashflow) versus rotation age. Furthermore its possible to alter the economic key variables that is the basis for the economic calculations. The variables consists of two parts: a) settings, and b) cashflow. The stand-specific settings are: Land Value (price of the land in \$/ha), Interest Rate (%) and Overhead (fixed annual costs per ha, e.g. admin). The cashflow is a list of all costs and revenues throughout the stands life. You can insert entries (fill out the empty top row and push add button), edit entries (change an entry and push save) and remove entries (push the red cross button next to the entry) in the cashflow. Costs should be input as negative values, revenues/income as positive values. The revenues from production thinning and clearfell are added automatically and can not be altered directly. The revenues are based on the stand conditions at thinning/clearfell (DBH and volume), and the assortment distributions (see under the *Settings* menu item for more information). You may need to add logging costs manually, unless you specify net-values in your assortment distributions.

The *Measurements* tab contains the facility to input fixed points (ideally measurements) for a stand. When there are measurements input for a stand, the growth model is automatically reset to the measured values. For example, if you specify a mean top height of 10 m at age 10 then the mean top height is (re)set to 10 at age 10 years – regardless of what the model predicts otherwise. You can set any combination of stocking, mean top height, and basal area - you must however always specify an age for the measurement to take effect. If you input several measurements for one stand age, the calculator will automatically calculate a simple averages (means) over all measurements for that age, and use the means in the growth model.

If your measurement data originate from a sample plot there is a calculator/converter tool available by clicking the calculator icon/button. The converter takes either plot-level information (plot area, number of stems, DBH and mean height) or tree-level data (area, tree number, dbh and height), and converts it into per hectare information. It is compulsory to input the area of the plot – otherwise stand parameters cannot be estimated. Diameter (DBH) is also compulsory for tree-level data, while individual tree heights are optional. The stocking per hectare is calculated from the number of trees input and the plot area. The mean top height is estimated from mean height and stocking¹.

Please note that there is no internal control of the measurement data - if you input nonsense, you get nonsense out.

Stand manager

The *Stand manager* is your personal library of stands, and it consists of a searchable list of your stands (sorted by forest, compartment, stand and substand). If you got more stands than is shown (by default 20 stands are shown) you can browse the rest of the stands using the "Next >>" and "<< Previous" buttons at the top or bottom of the stand list. Or if you wish to show more or less than 20 stands in each screen, change the number in the search form field "Show" to the number of stands you wish to show and press the "Search"-button.

The stand list normally presents a range of information for each stand – by default the current modelled conditions of each stand (i.e. age, stocking, mean diameter, mean top height, basal area and volume). For this to be calculated the system needs to know the planting time for each stand – stands without this information are not modelled, as the system cannot calculate the current age of the stand. You can also forecast/show the projected/modelled stand conditions 2, 5 and 10 years into

1) Mean top height (MTH) is estimated from mean height (MH) and stocking (n) using the following equation:

$$\frac{MH}{MTH} = a^{1 - \exp\left(b \frac{n-100}{100}\right)}$$

Where *n* is stocking (stems per hectare), *a* and *b* are parameters with values 0.9180 and -0.5098, respectively. Parameters were estimated using the *nlm* method in the statistical software package R (R Development Core Team 2005) and all available *Cupressus lusitanica* and *C. macrocarpa* data from the PSP system (Dunlop and Piilar 1990) as of January 2010.

the future for the stands that got a planting age. You do this by changing the "Time"-drop-down in the search form and pushing the "Search"-button.

The "Time"-drop-down has got a fifth option: "*At rotation age*". If you select this, the *Stand manager* will grow all stands to their specified rotation age (regardless of when they were planted) and show the stand conditions at rotation age. The stand information is then supplemented by economic key variables (average log price, NPV and IRR). This enables immediate comparison (economical) between stands/regimes (both hypothetical and real).

If you got many stands you can search for individual stands by forest, compartment, stand and substand. Simply input your criteria in the respective fields and push the "Search"-button. A wildcard is automatically added after any string you input. Hence, if you wish to find stands in Rotoehu forest, you may simply search for: Forest = "Roto". This will, however, also find stands in e.g. Rotoiti forest. You may also add a wildcard (%) manually if required (e.g. "R%u" will find Rotoehu and not Rotoiti).

The "Group by"-drop-down menu enables you to group your search-results at different levels (default is forest-level). The stand list (search result) is automatically split into individual tables based on the "Group by"-level, and summary statistics (area-weighted means and sums) are calculated for each "Group by"-level (except when the stand list is viewed in "*At rotation age*"-time). This is particularly helpful if you have stratified your stand into substands (e.g. based on growth conditions), and require an overall stand-level estimate. Set the "Group-by"-drop-down to the level you require and push the "Search"-button.

From the stand manager you can open any stand in the *Calculator* - push the "Show"-button next to the stand. Note that the name of the stand is shown in a green box above the stand tabs whenever you have selected a stand from your library. When a stand name is show above the tab, this is the active stand – any changes made (and saved) while a stand is active will be saved on/for that particular stand.

Settings

Under the *Settings* menu item you can set your default values for the economic variables; Rotation Age (years), Interest Rate (%), Overhead (\$/ha/year) and Land Value (\$/ha). These values only take effect when you are working on a new stand (and this has not been set manually). All stands in the manager will have their own individual settings, which override the global settings.

The measurement tools (in the *Measurements* tab in *Calculator*) allows you to input individual measurements/plots as either plot-level or tree-level data. The calculations requires the area of the plot to be input. Under settings you may set your typical (default) plot area/size – this is the default value in the area whenever you use the measurement/plot tools.

Another thing you set under *Settings* is your log grade/assortment distributions. An assortment distribution defines what percentage of total standing volume ends up in a given log grade, and what the price per cubicmetre is for each log grade.

Each individual assortment distributions is defined for a minimum stand diameter, i.e. basal-area-weighted mean DBH. If the DBH of the stand is larger than the DBH for a given distribution, then the stand qualifies for that particular distribution. When a clear-fell/thinning is evaluated the maximum (DBH) assortment distribution achievable is used. Say you have three assortment distributions (at DBHs of 30, 40 and 50 cm). Your stand has a DBH of 35 cm, then the economic valuation would use the distribution with DBH=30.

The percentage that is not specified in a distribution is assumed to be waste – i.e. zero value. The left-most column (%) shows what percentage of total standing volume is accounted for by each distribution.

Please note that there is no validation of your distributions. It is for example possible to define distributions that evaluate more volume than is present (sum of percentage by log grade larger than 100).

Tips and tricks

When you have a specific stand open (active) in the *Calculator*, and you want to start a new stand from scratch. Go the *Stand manager* – in the upper right hand corner is a button called "Start new stand". When you push this button you go back to your default stand (play-stand).

When you have a stand (#1) and want to model another stand (#2) which is quite similar to #1. Go to the *Stand manager*, find stand #1 in the list and recall it in the calculator by pushing "Show". Then go to the *Stand information* tab and in the bottom right corner you find a "Copy"-button. This way you get an exact a copy of the first stand (except for measurements), on which you can base stand #2. Following the copy operation, stand #2 will be active (prevents messing up the original, i.e. stand #1).

Changes to your default stand (play-stand) will also be saved when you for example add a thinning or push calculate – so if you wish for the map/satellite-image to always start in a particular place for a new stand – position the map to that location and push save. Next time you start a new stand or log in, the map will automatically be positioned at this location and zoom-level. Similarly, you can change the default species, rotation age etc.

In the upper right hand corner of the *Stand information* tab is a small print icon/button. When you push this button, all stand-information (except economics) are shown print-ready in a separate/pop-up window (please note that some browsers have pop-up blockers). This allows you to print out stand information sheets for each individual stand with all available information.

In the upper right hand corner of the *Stand manager* is a small print icon/button. When you push this button the current search results/stand list is shown in a print-ready format in a separate pop-up window – and the standard print-dialog is called. This enables you to print out customised stand lists for subsets/collections of your stands, e.g. your entire estate or individual parts.

If you wish to compare a range of thinning regimes for a given stand, you can do this by saving each stand in the stand manager. Just give the model stands a distinctive name (e.g. Model Forest). Then go into the *Stand manager* and search for that particular forest, and select Time "At rotation age". Also note that once you have saved the first stand, you can use the trick described above ("Copy stand"-button) to make many similar stands, on which you can then vary the treatment.

If you have measured several plots for one measurement occasion in a stand, you may input plot-level information (or tree-level) as individual measurements for the same stand age. The system will then automatically calculate a simple average over all measurements.

References

- BERRILL, J-P. 2004. Preliminary growth and yield models for even-aged *Cupressus lusitanica* and *C. macrocarpa* plantations in New Zealand. *New Zealand Journal of Forestry Science* 34(3):272-292.
- PILAAR, C.H., DUNLOP, J.D. 1990. The permanent sample plot system of the New Zealand Ministry of Forestry. In: Adlard, P.; Rondeux, J. (Ed.) "Forest Growth Data: Retrieval and Dissemination". Proceedings of joint IUFRO workshop S4.02.03 and S4.02.04, 3-5 April 1989, Gembloux, Belgium. *Bulleting des Recherches Agronomiques des Gembloux*.
- R DEVELOPMENT CORE TEAM 2005. R: A Language and Environment, R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. <http://www.r-project.org>