

Future Forests Research Kauri Calculator

Introduction

The Future Forests Research (FFR) Kauri Calculator is a web-based (online) tool for stand growth modelling and management of kauri plantations in New Zealand. The main purpose of the Calculator is to deliver scientific growth model information for kauri to foresters. The present document describes how to use the system. The Kauri Calculator employs the mathematical models developed by Steward et al. (in press).

The system is accessed through a web-browser using the url: <http://fastigatacalc.ffr.co.nz>. The Calculator supports most newer browsers, including Internet Explorer, Firefox, Safari, and Chrome. The only technical requirement is that JavaScript is enabled in the browser. To identify individual users it is a requirement that you log on to the system.

Overall

Once you are logged in, the main screen of the Kauri 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, Log prices and Stand manager), and then your "login" 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 1 ha 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 'model-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 'model-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 sub-stand. 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. Whenever there is a stand name above the tabs in the Calculator this is your active stand – any changes or 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 the 'main part' of the screen is divided into two panes. On the left you have a green box with Starting conditions, Growth conditions and Thinning schedule, on the right you have a set of light green/grey tabs (called Stand tabs) with various stand information (graphs, growth numbers and economics).

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 about starting conditions:

1. Age
2. Stocking
3. Basal Area
4. Mean Top Height (m)

This information is all measured data on current stands, or is estimated conditions to project forward, however it is recommended that starting age should not be less than 5 years, preferably >10 years.

The second part of the Growth conditions is where you input your site index, rotation age and report intervals.

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 start 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 is 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 third 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. A thinning coefficient less than one 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 van der Coff and Kimberley (2005) 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 need to push the 'Calculate' button at the bottom for the changes to take effect.

Stand tabs

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

1. Growth (graphs)
2. Growth (numbers)
3. Economics
4. Measurements
5. Stand information

The Growth (graphs) tab holds a graphical representation of the information in the Stand growth tab. Four graphs are shown: Stems per hectare, mean top height, basal area and standing volume - all plotted against stand age (years). Hover the pointer over any graph will give the actual numbers at any age. The effect of any thinning applied to the stand is represented on the stocking, basal area and volume graphs.

The Growth (numbers) tab holds a model/projection of the stands life by listing stocking, mean diameter, mean top height, basal area, volume and thinnings volume throughout the stands life (until rotation age). The table also shows cut volume as well as the mean DBH of thinnings. 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 dark-green and measurements in light-green. 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 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 it's possible to alter the economic key variables that are the basis for the economic calculations. The variables consist 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 cannot 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 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 stocking 1. Please note that there is no internal control of the measurement data - if you input nonsense, you get nonsense out.

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.

● **Log prices**

The calculation of revenue is based on the assortment distributions (volume by log grades). An assortment distribution defines what percentage of total standing volume ends up in a given log grade, and what the price per cubic metre is for each log grade.

The assortment distributions page is split into two. The top box contains the currently active distributions, which are used in the calculator. The bottom box contains your own library of distributions. This allows you to save your currently active distributions in the library, and you may also use any distributions from your library in the calculator. Your library will always contain the default distribution, so you can always return to this

distribution.

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, 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: 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).

To save your current distribution in your library input a name for the distribution in the empty box next to the "Save current distribution as"-button and push the button. When you have one or more distributions in your library, a list of distributions is shown above the row to insert a new distribution.

Once you've saved a distribution you may replace the currently active distribution by clicking the 'Use this distribution' button next to the distribution you want to use.

● **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 sub-stand). 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

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 wild-card 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.

● ***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**

- Steward, G. A., Kimberley, M. O., Mason, E. G., & Dungey, H. S. (in press). A growth and yield model for New Zealand kauri (*Agathis australis* (D. Don) Lindl.) grown in even-aged planted forests. *New Zealand Journal of Forestry Science*
- van der Colff, M., & Kimberley, M. (2005). Modelling *Eucalyptus fastigata* growth in New Zealand. *Eucalypt Cooperative Report No. 3*. : Ensis/Scion.