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PART 1

USER'S GUIDE

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ForestCalc – **Forest mensuration application**

ForestCalc software includes the following modules:

- **Timber analysis** – single (felled) stem volume and timber dimensions.
- **Timber volume** – single (standing) stem volume and dimensions computed by using 1) volume equations and tables or 2) taper curves (valid in Finland, *Laasasenaho 1982*).
- **Timber volume for several trees**. Calculation of several stems' volumes in the user-friendly sheet.
- **Sample plot** result computing (single-sample).
- **Compartment (stand) data results.** Computing of results from compartment data or based on point (relascope) sample plots. This feature is available only in Finnish version of the program.

This manual, Part I, includes the user's guide for using the software. Manual Part II includes description of the database structure and the parameter files.

The program is a stand-alone application. However, a database management application is needed to edit the parameter files (as MS Access).

The freeware version is available only in English and Finnish.

Warning: the revision of English language of this manual has not been done.

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1. Installation

ForestCalc runs under Windows ME/ 2000 / XP / VISTA. In Windows95/98/NT it has not been tested.

Notice.

Unzip the downloaded file. First, close all applications before installation, and in log in with *Administrator* rights. Then run the installation file. The same file also works as uninstaller, if needed.

The application can be installed to any drive and folder.

Start the program, and if needed, change the default language (*Asetukset, Vaihda kieli*). Then set the working directory (*Asetukset/Settings*). This is the default location for the data files. Use double click!

ForestCalc localized settings:
See more about the parameter files **Treepara.mdb** and **ForestPara.mdb** in Manual Part II

2. Starting to use the software

2.1. About localization of ForestCalc

ForestCalc can be localized to any conditions where the metric system is in use. All data – parameters, input data, result data – are saved into MS Access2000 format databases. These files can be read or edited by database management software.

The user can change the following parameters:
- Currency unit, 2nd currency unit (optional), conversion factor between units (optional)
- Tree species codes (number or text), names, biomass density factor (optional), charcoal conversion factor (optional)
- Tree volume functions (3 function groups). The program uses equation parsing to solve the equations.
- Height curves (there are already the following: Näslund, Polynomic, Michailoff).
- Timber prices (by species and timber classes). By cubic volume or/and by stem.
- Timber dimensions (in bucking, but works only in Scandinavia)
- Timber tables (percentage tables are in ASCII format, based on diameter and tree height) or Bole form factor.
- Increment period (past increment). Default value is 5 years. Measured usually from a drill sample.

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The freeware version is available only in English and Finnish. The program supplier can add new languages, because all the words in ForestCalc are written into an ASCII file which is compiled into a part of final EXE - file.

2.2. Starting

The program starts from shortcut **ForestCalc Standard**.

If needed, change the default language (*Settings, Change language*) *(Asetukset, Vaihda kieli)*. Set also the working directory for data (*Settings, Set working directory*).

In the program main window, please check also all setting (menu command *Settings*).
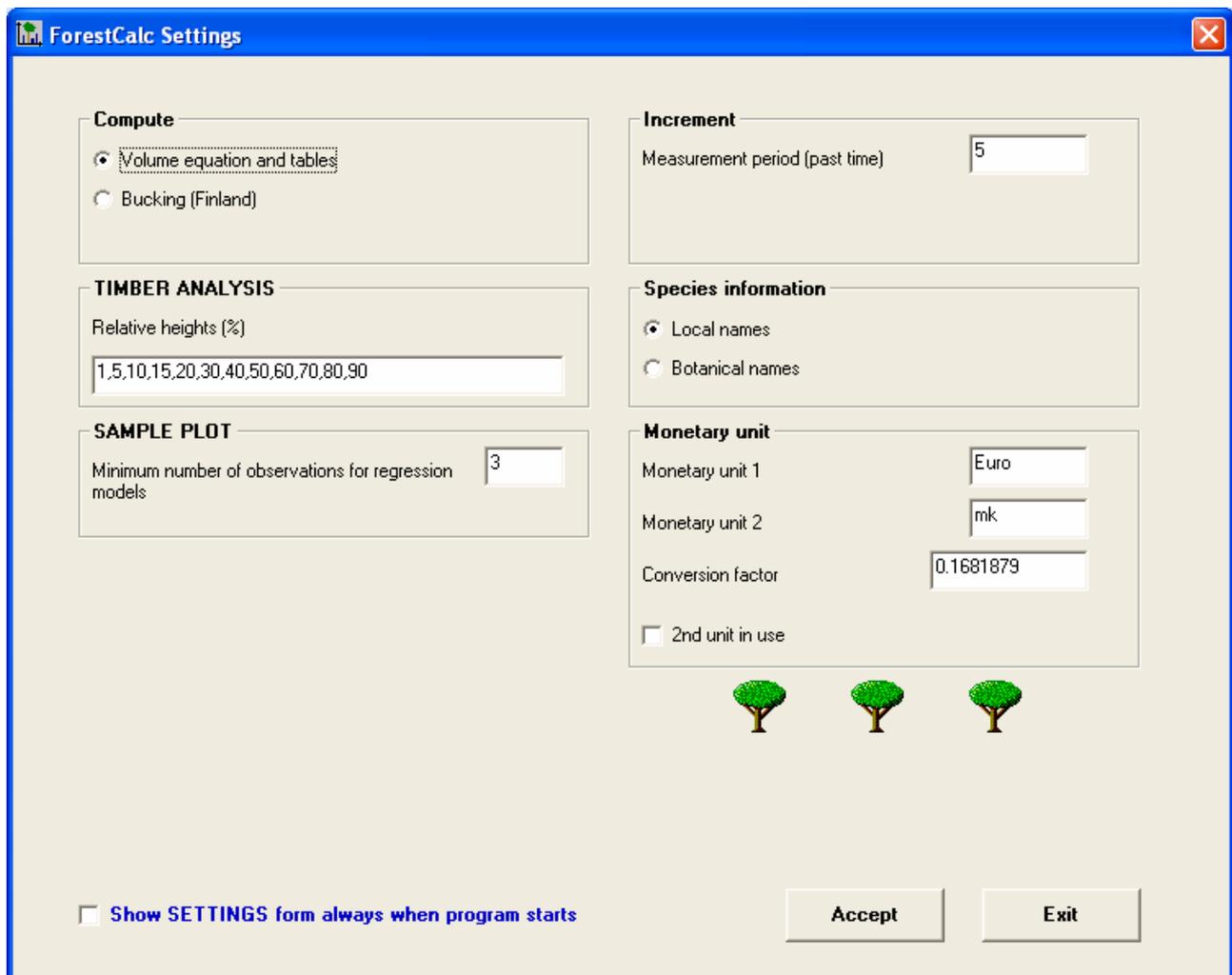
Figure 3. Screen example of timber analysis.

The timber prices are always expressed as main currency unit in the parameter file.

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3. Main functions

3.1. Timber analysis (felled stem)

This module can be used to compute a single stem's timber and bark volumes (in cubic decimeters=m³/1000, liters) and biomass (kg). The program draws a taper curve and this image can be copied to other applications via clipboard.

Figure 3. Screen example of timber analysis.

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3.1.1. Data input

First, selecting the menu command *Tree database, New tree.*
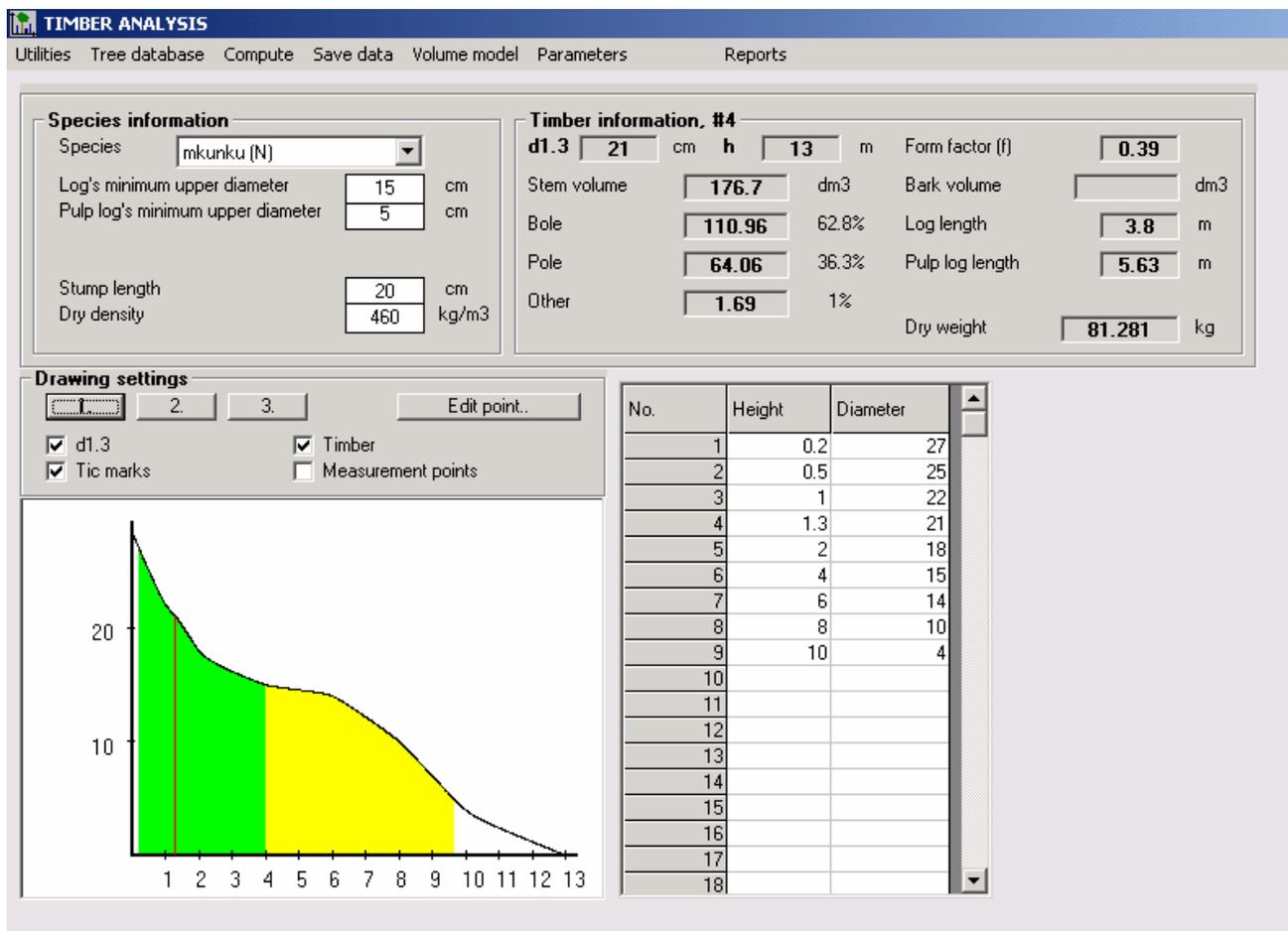
The program asks:

- Tree number?
- Are bark dimensions measured?
- Total height of tree (m)
- Do you use relative heights (default relative height values come from database; see description of *Treepara.mdb, Manual Part II*) OR given measurement heights

After this enter the input data to grid, starting from tree's bottom. If bark thickness is measured, it is given as the sum of two measurements from two sides of the stem (in millimeters). If DBH is measured, enter it too. Then select tree species. If applicable, give also log and pulp log minimum upper diameters (cm), stump's height (cm) and dry weight (kg/m^3).

3.1.2. Computing and saving data

The program computes stem curve by using Späth (1974) rational spline equation (3rd degree polynomical equation). Two extra points are created in computing: one below the bottom (negative height), and the second one above the top of the tree. Spline function is computed for each range of two measurement heights.

Rational spline replaced "traditional" cubic spline equation in ForestCalc version 2.4.0. Rational spline uses so-called *tension factors* for left and right side of the spline curve. The default values are 5 (left) and 5 (right). If the user wants to get results by using cubic spline without tension factors, then use the menu command *Parameters* and enter value zero for tension factors, both for left and right parameter.

The program computes diameter at breast height (if it is not given in the input data), form factor, stem and bark volumes and timber volumes. Also the lengths of log and pulp wood parts are computed. If the bark dimensions are given, stem curves inside and outside bark are computed with the same method (by rational cubic spline).

Method for computing volume is selected in the menu command *Volume model*. Volume is computed always starting from stump's height and the unit is **m^3/1000** (liter).

If you need to edit any data that was entered in the input grid, press the command button '*Move point'*. New data will **not** go directly to database (you must save the data again).

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Selections in the frame **Drawing setting**:

- **1**, **2** and **3**: image width (width **1** also gives grid visible)
- d1.3   = red line at location of DBH
- Scales   = scale values and tic marks
- Timber   = log timber part (green), pulp wood part (yellow)
- Measurement points = blue lines at the measuring points

Input and computed output data can be saved selecting _Save data_. Information is saved into a file _AnalysisTrees.mdb_, which includes two tables: _AnalysisTreeData_ for the input data and _AnalysisTreeResult_ for the result data. The file is located in the current data directory.

The menu command **Results** opens Notepad and a view to the result database: you can get all tree results to Notepad in semicolon separated format. You can copy all data from Notepad to clipboard and paste it to MS Excel. In Excel select _Data, Text to columns_. (semicolon mark as separator).

3.1.3. Retrieving a tree and deleting

Tree data from database are retrieved selecting _Tree database, Retrieve_. This command will also retrieve given log and pulp log upper diameters.

If user wants to save data collected from different regions, the easiest way to do this is to first create a new directory for each region, and then just change working directory to get data from right region.

Input and result data for one tree are removed from the database selecting _Tree database, Delete._

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3.1.4. Data transfer and printing

Taper curve image goes to clipboard with menu commands _Utilities, Copy image to clipboard_. Diameters along taper curve can also be copied via clipboard (_Utilities, Copy diameters to clipboard_) for example to word processing software. Diameter dimensions can be outputted with two methods: 1) 10 cm intervals from stem or 2) from the relative heights. If the 10 cm interval is selected, in word processing software the columns fit well when the text font is `Courier`. There is an example of output data of a 15 meters tree and each row in the matrix contains diameters equal to one meter of tree height.

```
25.9  25.3  24.8  24.4  24.1  23.8  23.5  23.2  22.8  22.3
21.7  21.2  20.6    20  19.5    19  18.6  18.2  17.9  17.7
17.5  17.3  17.1  16.9  16.8  16.6  16.5  16.3  16.2  16.1
  16  15.9  15.8  15.7  15.7  15.6  15.5  15.5  15.4  15.3
15.3  15.2  15.2  15.1  15.1    15  14.9  14.9  14.8  14.7
14.7  14.6  14.5  14.4  14.4  14.3  14.2  14.2  14.1  14.1
  14    14  13.9  13.9  13.8  13.8  13.7  13.7  13.6  13.6
13.5  13.4  13.3  13.2  13.1    13  12.9  12.7  12.5  12.4
12.2    12  11.8  11.6  11.4  11.1  10.9  10.7  10.5  10.2
  10   9.8   9.6   9.3   9.1   8.9   8.7   8.5   8.3   8.1
 7.9   7.7   7.5   7.3   7.2     7   6.8   6.7   6.5   6.4
 6.2   6.1     6   5.8   5.7   5.6   5.5   5.4   5.2   5.1
   5   4.9   4.8   4.6   4.5   4.4   4.3   4.2     4   3.9
 3.8   3.6   3.5   3.3   3.2     3   2.8   2.7   2.5   2.3
 2.1   1.9   1.7   1.5   1.3   1.1    .9    .6    .4    .2
   0
```

The results can be recalculated double clicking the taper curve image or selecting menu command _Compute_.

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3.2. Timber volume

With module **Timber volume** the user can compute stem's volume, value and shares. Moreover, the user can test new volume equations in the model editing window. Two methods for timber volume calculation are:

- Volume equations (from database)
- Taper curves by *Laasasenaho 1982* (particular to Finland)

Figure 4. Module Timber volume. In this case the timber volume is computed with two methods (the upper results: volume equations; the lower results: Laasasenaho's taper curves).

The user can select volume model type as one of these:

1) Diameter (d) as predictor-variable (Function is read from TreePara.mdb, table VolumeModel1)
2) Diameter (d) and tree height (h) as predictor-variables (Function is read from TreePara.mdb, table VolumeModel2; **this is the default**)
3) Diameter (d), upper diameter (d6) and tree height (h) as predictor-variables (Function is read from TreePara.mdb, table VolumeModel3). This model is not usable outside Scandinavia.

So, at least species and diameter are required for computing volume of a single stem.

When **taper curve calculation** (Laasasenaho 1982) is selected, then the stump height and/or the ending height of the log part of stem can be given. If no stump height was given, the program uses stump models and the result can be seen as cursive text.

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Before computing, the program checks species' relations to volume models in database (See further information in Manual Part II). The program computes total timber volume by solving the equation with the help of equation parser. Timber percentages are got from text files for that species.

If timber volumes are computed by using taper curves, then they are also computed with that taper curve. In this case, user can select different dimensions and prices for log and pulp wood (e.g. company rules or geographical area) selecting menu command *Dimensions and prices*. The selected dimensions are made visible with command *Utilities, Show timber dimensions* (see the next figure), which are updated <u>only after</u> computing results. The text is as following:

| Min. Log | 16 cm (200)
4.3 ~ 6.1 ~ .3 | Min. Pulp | 8 cm [110) | Waste | (20) |

- Upper row: log minimum upper diameter and price in parenthesis, pulp log minimum diameter and price, and other use wood price in parentheses
- Lower row: minimum log length, maximum log length and interval value (m).

Volumes and values are presented as a pie chart: the chart is drawn from results of taper curve method if that one is selected; otherwise it is drawn from results of volume equation.

The user can get volume equations visible selecting *Utilities, Show volume model*. The user can "play" with the model and try different versions of it, and in these cases the model window header text becomes '**---?---**'. Clicking of the *Compute*-button will give results, if the equation parser can solve the given mathematical formula. The user can not permanently edit or delete models in the database because these are in *read-only* -mode.

Notice

The model window is extremely useful when testing new volume models, before writing them into the parameter database. See more about writing equations in Manual II.

In case there is a list of models to choose from, that model which was used in computing the result, is visible only after clicking on the *Compute*-button. More information about model lists are in Manual Part II.

Notice! If the user writes a new model to screen or edits an existing one, this is so-called <u>enforced model calculation</u>, and rule checking of volume models is disabled. The enforced model is released by clicking any species name in the list. Any model on the screen can be enforced to stay active in computing simply by typing '+ 0' at the end of the equation. Rules for writing equations are explained in Manual Part II.
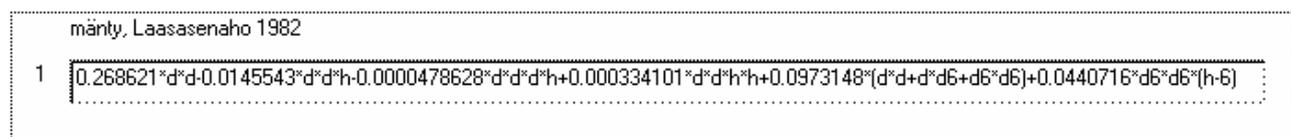
mänty, Laasasenaho 1982

1 | $0.268621*d*d-0.0145543*d*d*h-0.0000478628*d*d*d*h+0.000334101*d*d*h*h+0.0973148*(d*d+d*d6+d6*d6)+0.0440716*d6*d6*(h-6)$

Figure 5. An example of a volume model retrieved from database.

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3.3. Timber volume for several trees

3.3.1. General

With module **Timber volume (several trees)** the user can compute volume and value of several stems. The program saves the input data and results to an Access database. Data are saved to a database, which can include several tree groups. The same database file, covering one area, can contain groups measured with different variables. The program does not give out results by hectare or by stand.

3.3.2. Regional database and data input

Plots are arranged according to region; each plot belongs to one region. Before starting to work with a new region's data, the regional database must be created with *Utilities, New region file* and user gives a region number (integer). In practice, the program makes a copy of an empty file to the new name. For example, if region number is set to 32, the program makes the following copy:

        MoD_TreeGroup.mdb -> **T***0000032.mdb*   (file for input and result data)

If a file having the same region number already exists, no file is copied and the program gives a warning.

Save a new tree group with command *Tree database, New*. Next give area code and group code. If the database exists, there will be a sheet visible where the input data is give to white cells, green cells are for the results. *Species* and *Diameter* are obligatory. The measured variables are selected from the menu command *Variables*.

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Figure 6. Screen of timber volume calculation module.

Figure 7. Selection list of input variables. Bole height means bole's height from the ground level.
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3.3.3. Calculation and saving the data

Do the computing of results with command ->*Compute*->*Save.* The program calculates volumes, values and column totals. The volume calculation method depends on selection in the menu *Dimensions and prices*:

1. Calculation by volume equations is the default method
2. Bucking is valid method only in Scandinavia (Laasasenaho's taper curves, 1982)

Figure 8. Selection of timber price group and volume calculation method.

The user selects the volume equations, the computing selects the best model according to the variables, as follows:

a) Only diameter is given (d) -> calculation by using one explicatory variable in volume equation, v=f(d). Timber volumes are not computed.

b) Diameter and tree height are given -> computing with model with two explicatory variables in volume equation, v=f(d,h). Timber volumes are computed.

c) Diameter, upper diameter (d6) and tree height are given -> computing with model with two explicatory variables in volume equation v=f(d,h,d6). Timber volumes are computed.

If the user selects taper curves (bucking, not valid outside Scandinavia), then

a) Only diameter is given (d) -> No volumes are computed.

b) Diameter and tree height are given -> Volume is computed with Laasasenaho taper curve (2 variables). Timber volumes are computed by parameter table details (by species)

c) Diameter, upper diameter (d6) and tree height are given -> Volume is computed with the help of Laasasenaho taper curves (2 variables). Timber volumes are computed by parameter table details (by species)

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3.4. Sample plot

3.4.1. Measuring sample plot data

Measurements come from a sample plot, which can be one of the following plot types:

- Rectangular,
- Circular,
- Concentric,
- Relascope.

Tally trees are selected and measured according to diameter in concentric plot. For example, trees less than DBH 10 cm are measured on a plot radius of 3 meters, other trees on a plot radius of 6 meters.

There are two alternative methods to measure the plot data:

1) All trees are measured as tally trees (including stump, if the removal is needed). Then part of the tally trees are selected as sample trees and measured more detailed. Tally trees are marked as individual trees or as total number of each species in diameter categories.

2) All trees are measured as sample trees and enumerated individually. Sheet 'Tally trees' is left empty, all data is entered on the sheet 'Sample trees'. In this way, one sheet is filled in. See sheet **Variables** and check box "All trees as sample trees".

The following variables can be measured on the plot (marked with '**+**' means that this variable is obligatory):

+   Species code (text)
-   Tree class
+   Diameter at the breast height (cm)
-   Diameter of stump (cm) (written into the field 'Diameter' in grid)
-   Tree location (coordinates or azimuth & distance)

Tree class codes are the following:

0 = other use (no log and pulp computed)
1 = (remaining) log timber
2 = (remaining) pulp wood
3 = marked log timber (to be removed in thinning)
4 = marked pulp wood (to be removed in thinning)
5 = stump
6 = dead tree

If the tree class has no meaning for the program user and not needed at all, then it is practical to mark all living trees with code one (1). The following data are taken from sample trees:

+   Species code
+   Diameter at breast height (cm)
-   Diameter of stump (cm) (written into the field 'Diameter' in grid)
-   H, Height (m)
-   Bark thickness, total of two sides (mm)
-   Upper diameter d6 (cm)
-   Hc, Crown height or Bole height (m)
-   Age (years)
-   Radial increment *Ir* at DBH (mm, during the growing period, default value in the database is 5 years)

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- Height increment *Ih* (dm, during the growing period)

Different sample trees can be selected for different measurements. For instance, height can be measured from every sample tree and age and increment can be measured from every second sample tree. Computation of growth is possible if at least radius increment has been measured.

3.4.2. Regional databases

Plots are arranged according to region; each plot belongs to one region. Before starting to work with a new region data, the regional database must be created with *Utilities, New region file* and user gives a region number (integer). In practice, the program copies two empty files to new names. For example, if the region number is 31, the program makes the following copies:

> *MoD_Plot.mdb* -> **D***0000031.mdb*   (file for input data)
> *MoR_Plot.mdb* -> **R***0000031.mdb*   (file for result data)

If a file having the same region number already exists, no file is copied and the program gives a warning.

3.4.3. Input of new sample plot data

Add new plot data by selecting *Plot database, New*. Next give region and plot numbers. If the plot number already exists or region file is missing, the program gives a warning. If the numbers are accepted, the user gets a new tab sheet (Figure 10). For each tab sheet enter the information: first select plot type and measured variables. Then press **SAVE**-button. If trees are measured as number of cases in diameter class, check the box 'tally trees in diameter classes'. Then fill in forms (tabs) *General data*, *Tally trees* and *Sample trees*.

*** NOTICE! Press SAVE after filling in every sheet ! ***

Obligatory fields in general data form are *Plot number, Plot size* or *Relascope factor*, and *Date*.

In rectangular plot there is the term of 'main side': this means plots azimuth angle in degrees, which starts from plot's origin (south-west corner) to northern direction (default value is zero degrees). In the input sheet term 'Length' means length of main side.

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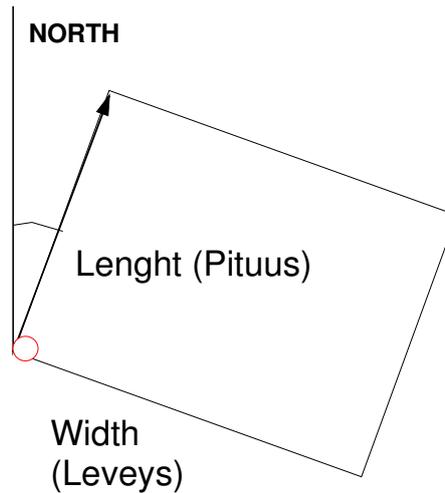
Figure 9. Rectangular sample plot and main side (arrow).

In sheet 'Tally trees' fill in all information for trees. If trees are tallied in diameter classes, then field 'Tree number' can be left empty.

Sample trees can have missing input values. A missing data in grid's cell can be left empty or marked with zero (0). An exception: tree class code 0 means *other use tree* (a tree for which log and pulp wood are not computed).

Figure 10. New sample plot variables are selected from this sheet.

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3.4.4. Data viewing and editing

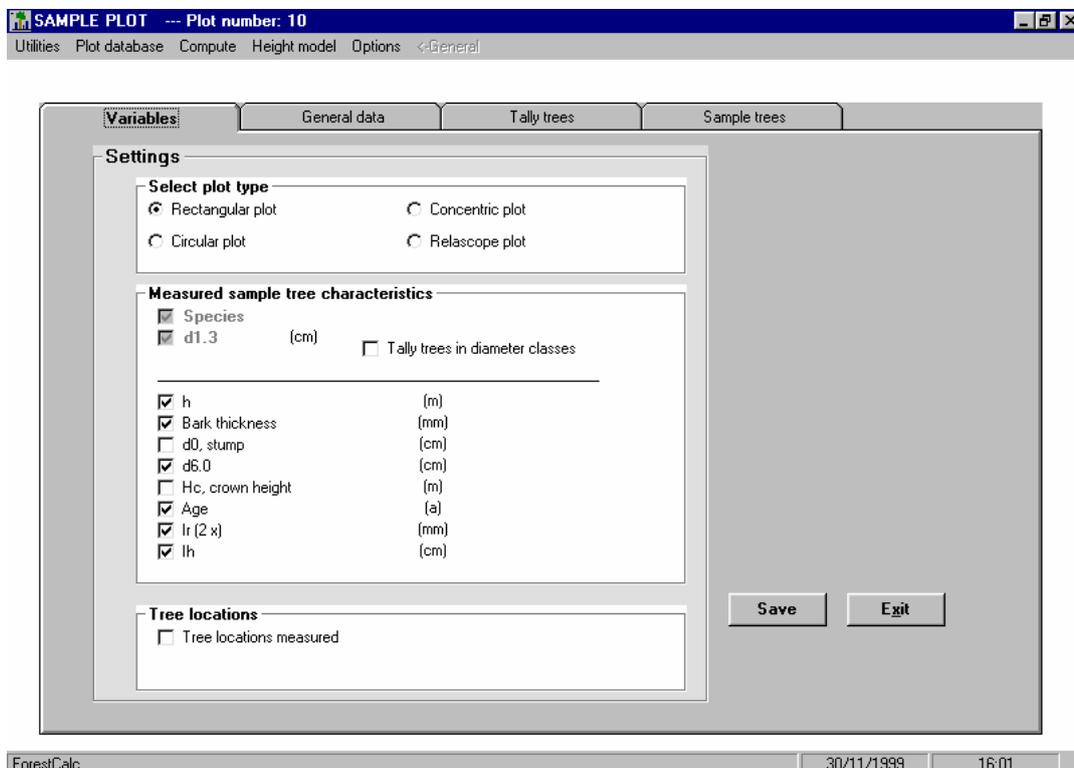The user can retrieve plot data from the database for editing and computing with the command *Plot database, Retrieve*. If the user edits any information in sheet 'Variables' and then presses SAVE-button, the tab sheets disappear and the data must be retrieved again.

3.4.5. Data deleting

A single plot is deleted from a region file by selecting *Plot database, Delete*. If the plot with given number exists, programs asks to confirm this selection.
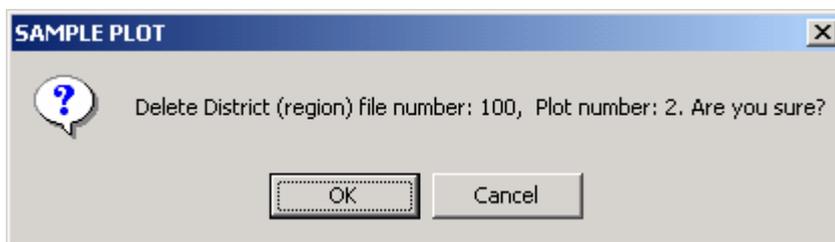

Figure 11. Confirmation to delete a plot from the database.

A whole region's file can only be deleted by using commands from the operating system. Both data file and result file should be deleted.

3.4.6. Computing of results

After saving all data to the database, user can start result computing by pressing menu commands *Compute, Compute.* Functions are created for only those variables which have been selected and entered. Regression models are computed for a minimum of 3 observations. The minimum value can be increased through command *Compute, Regr. N*. If for some species there are not enough (at least the minimum number) observations of some variable (e.g. height), then the regression model for this variable is computed by adding in so-called corresponding (substitution) species list, which is taken from database **Treepara.mdb**, table *TreeSpecies,* field *CSpeciesList*. The program collects observations (of corresponding species) as long as there are enough observations. If number of observations is insufficient, then the model is not solved.

Example 1.

> Corresponding list for spruce (code 2) is the following: 1,3,*
> If there are not enough sample trees in spruce to compute the regression model for age, then first all pines (species code 1) are also selected;
> if this not enough, then all birches are chosen (species code 3);
> if this not enough, then finally all age sample trees are chosen.

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Example 2.

> If corresponding list for some species is left empty, then this information is regarded as all species in sample trees are selected (same as '*')

Checking of minimum observation number and computing of models is done for each species, and for each function.

The user can select a height model form from menu command *Height model* (See more information in Table 1 later in this text).

The program computes first all function parameters for each species. After this there are two methods depending on the input method:

1) If the tally trees and sample trees were entered separately, the program computes all estimates by models, except diameter.

2) If all the trees were entered as sample trees (and tally tree sheet is empty), the program uses always the measured values, only the missing input values are computed my models.

The hourglass icon stays on the screen during computing. When processing is complete, user can select different outputs in the result window.
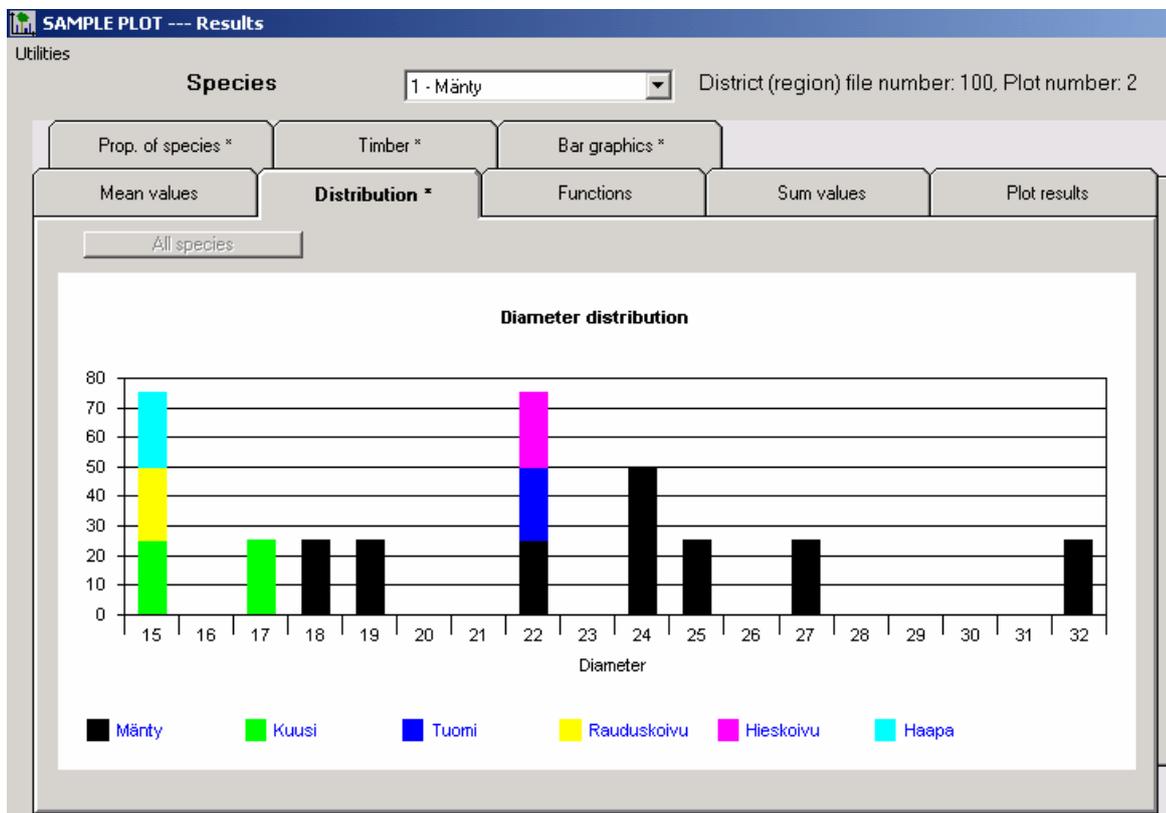
Figure 12. Example of result screen: diameter distribution can be drawn by selected species or by all species.

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The results for the whole plot are in tab sheet 'Plot results' (Figure 13).
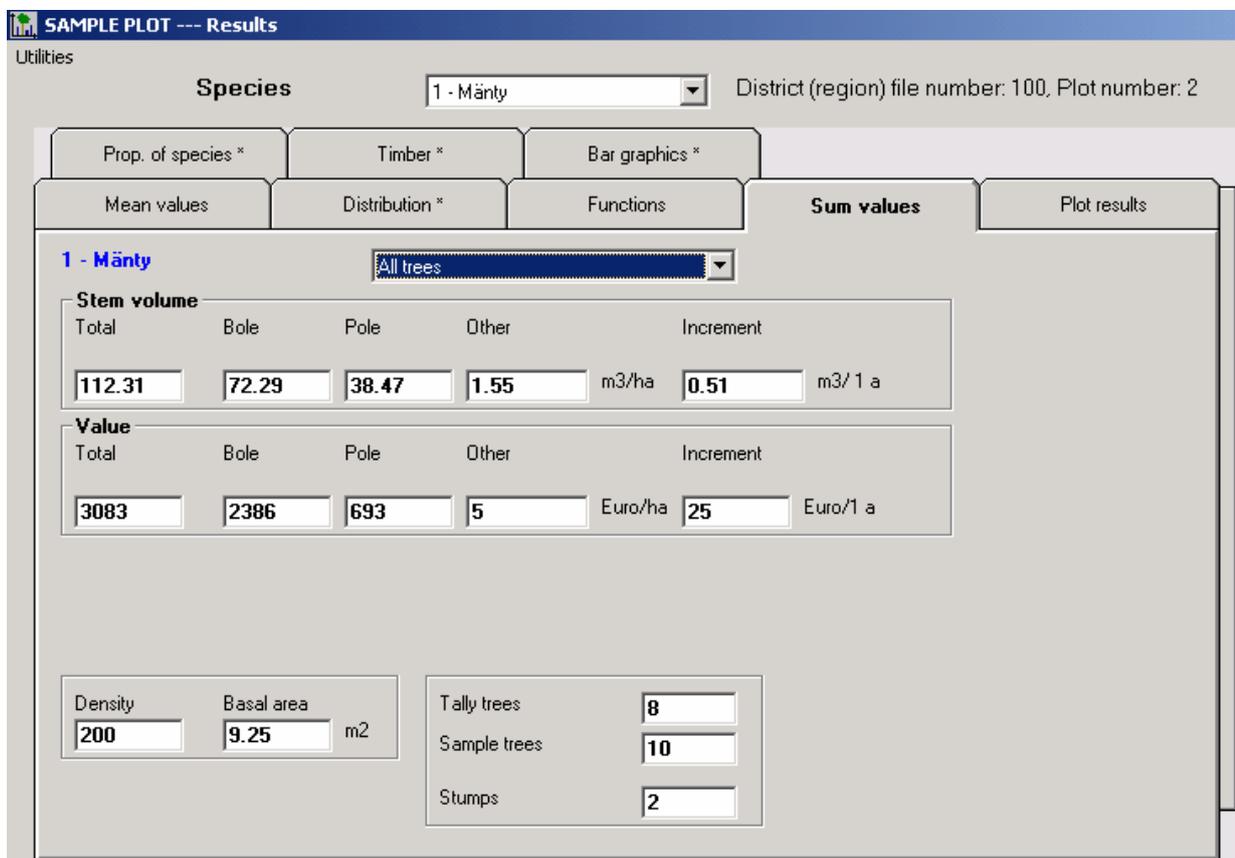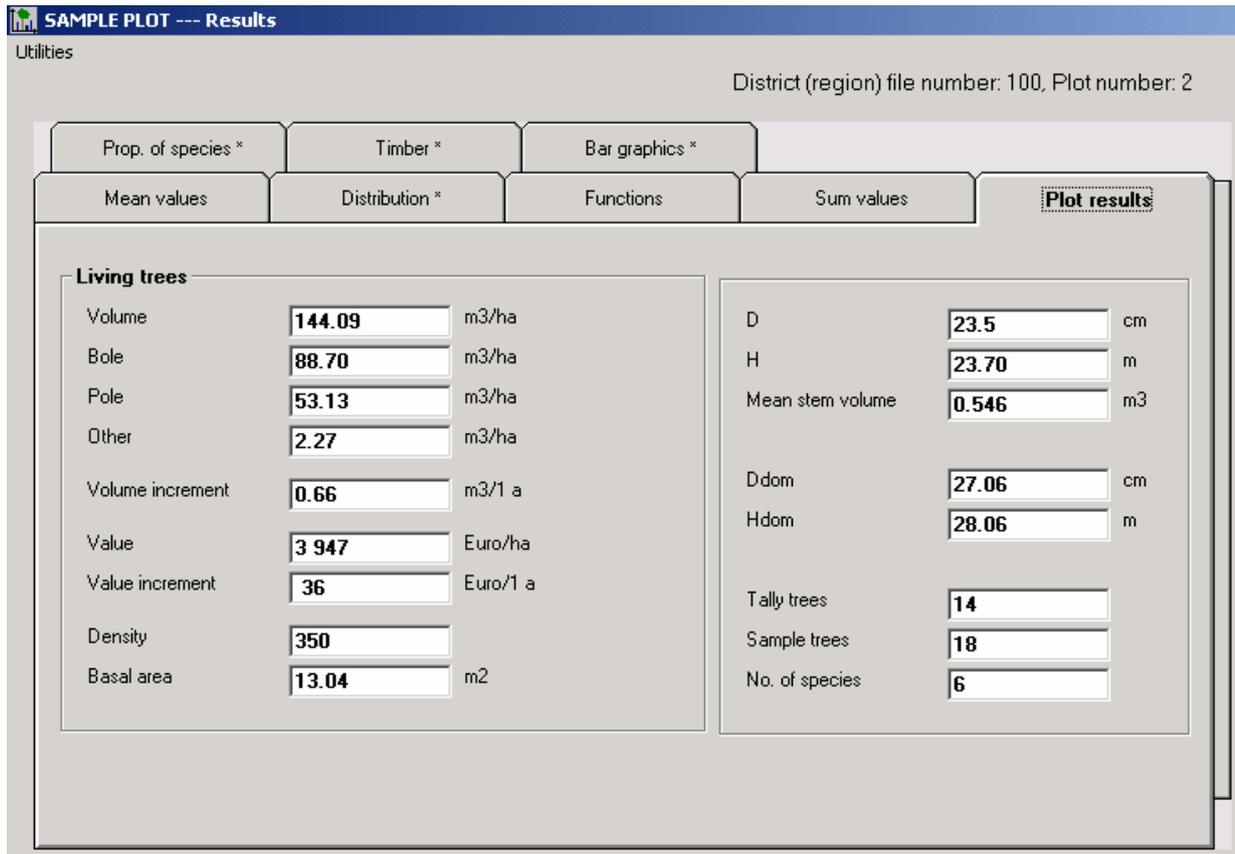

Figure 13. Plot results can be seen by all trees, by species or by tree classes. The removal is computed from given stump data.
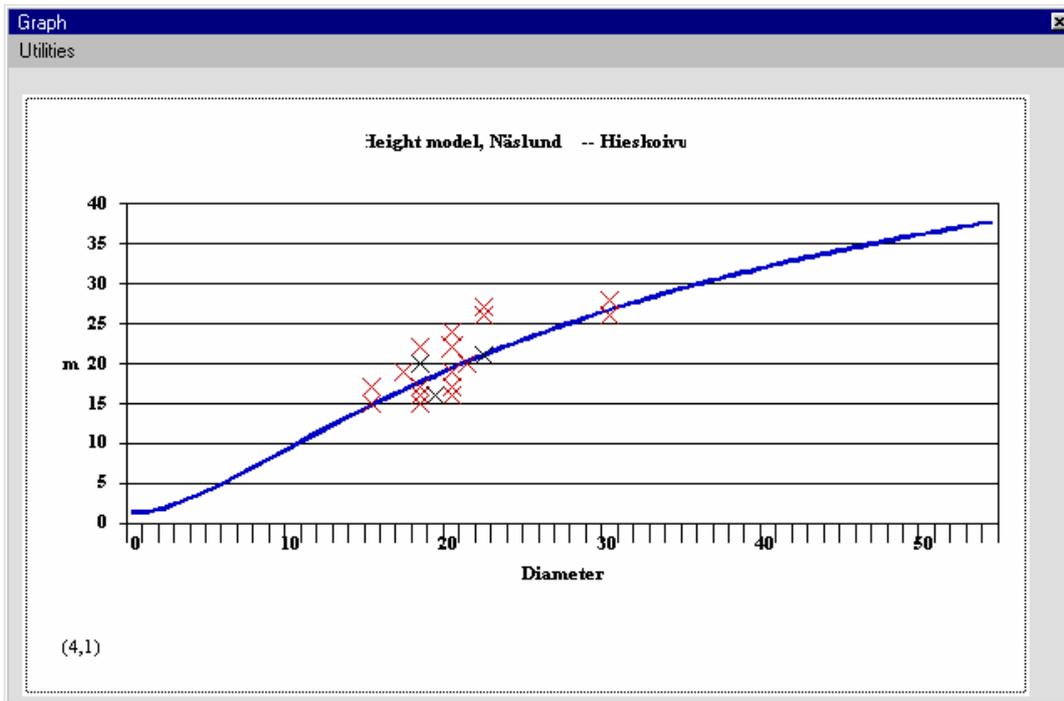
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Figure 14. Plot results (*Functions*). The fitted model is as a line and observations as points. Accuracy of observation points does not fully match with original data, because height data in the image is rounded to nearest integer value. Values in parenthesis indicate species, which are used in computing: (* = all species). Cross point colors: black = species of interest, red = other species.

3.4.7. *More about computing*

The user can define period for growth: in Finland this is usually 5 years (default value in program). This information can be set in database *Treepara.mdb,* table *ProgramParameters*.

The program uses two-predictor regression files, which are used to get variable values for tally trees. The program computes parameters (*a* and *b*).

(1) Height model
The following models are in the setup version: Näslund height curve (default), polynomic curve, and Michailoff's (Schumacher) model. Model is selected from menu command *Height model.* The user can add new (two parameters) model into database, if that model can be solved with regression analysis.

The program can correct "illogical height curves": For instance, Näslund model a-parameter may not be negative or Michailoff model a-parameter may not be positive. An illogical curve may emerge in case that the observations (*d,h*) are as follows: (24,26),(25,23),(26,22). So, the bigger trees (at DBH) are shorter. In this case, uncorrected models would give unrealistic heights for small diameter trees: even more that 1000 meters!

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Table 1. Height models

Name	Equation	Linearized equation	Y' (Lin. form predicted variable)
Näslund	$h = 1.3 + \dfrac{d^2}{(a+bd)^2}$	$a + b \times d$	$\dfrac{d}{\sqrt{h-1.3}}$
Polynomical	$h = 1.3 + a \times d + b \times d^2$	$a + b \times d$	$\dfrac{h-1.3}{d}$
Michailoff/ Schumacher	$h = 1.3 + ae^{-\frac{b}{d}} = 1.3 + e^B \times e^{\frac{A}{d}}$	$A + B \times d$	$d \times \ln(h-1.3)$

(2) Bark
$$b = a_2 + b_2 d$$

(3) Stump diameter
$$d_0 = a_3 + b_3 d$$

(4) Upper diameter (d6)
$$d_6 = a_4 + b_4 d$$

(5) Crown height or Bole height
$$h_c = a_5 + b_5 d$$

(6) Age
$$t = a_6 + b_6 d$$

(7) Radius increment
$$i_r = a_7 + b_7 d$$

(8) Height increment
$$i_h = a_8 + b_8 d$$

In all equations there is the predictor variable d, which means diameter at breast height (cm). All equations are solved by species. If there are not enough (default=3) sample tree data of certain species, the program uses corresponding species list to collect sufficient number of observations (see previous chapter).

The program computes correction factor for height model as follows: total sum of heights of sample trees is divided by total sum of heights of sample trees computed by height model. The program uses only sample trees of one species in computing the correction factor by species.

> *In the other words, if only spruces and pines were measured as tally trees, but there are not enough spruces in sample trees for computing height model, then all spruces and pines are used for computing of model parameters. But correction factor for spruce is computed only by using spruce sample trees.*

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The expansion factor (number of trees per hectare) and basal area (per hectare) are computed for each tree. In relascope plot, basal area of each tally tree is equal to relascope factor and stocking (number of trees per hectare) is computed with the formula:

$$n_i = 4/PI * BAf / d_i^2 \quad = 1.27323 \ * BAf / d_i^2$$

where n_i = stocking (trees/hectare), BAf = relascope factor, d = diameter (in meters)

The expansion factor for rectangular and circular plots is calculated by dividing 1 hectare (10000 m^2) by the sample plot area. To put the plot on a per-hectare basis, tree basal area is multiplied by the expansion factor and summed for all trees on the plot. In the concentric plot, the principle of calculation is similar to circular plot, but each tally tree's plot area is relative to its diameter.

If increment has been measured, volume of each tally tree at the beginning of the growth period is computed (default 5 years back from measuring time). First, the program computes diameter inside bark, but if bark has not been measured, a default bark thickness 10 % of diameter is used.

Second, the program subtracts diameter increment (=2 x radius growth) from diameter inside bark, and the result is diameter inside bark at the beginning of calculation period. Third, this diameter is transformed to diameter outside bark by assuming that bark's thickness relative to diameter stayed stable. Tree height at the beginning of calculation period is calculated by subtracting height increment from current total tree height. If no height increment model is available, the program estimates tree height in the past with the height curve model.

For volume calculation user can select the method: 1) two variable volume model (d,h), or Laasasenaho (1982) taper curves (bucking).

Figure 16. Selection of timber group (dimensions and prices) and timber volume calculation method.

Log and pulp wood are computed in case of 'Volume equation and tables' by multiplying total volume with **log and pulp wood percentages**, which are read from ASCII files (see parameter file *Treepara.mdb*, table *TreeSpecies* in Manual Part II).

In bucking, log and pulp wood are computed using the taper curve and selected timber dimensions. If increment data are available, the program also computes timber volumes in the past.

Stem value is computed by multiplying timber values by prices and totaling the figures. Mean annual volume and value increment are calculated by subtracting volume (or value) at the beginning of growing period from current volume, then the residual is divided by length of growing period.

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Stand results are the sum and mean figures. Sum figures are computed by multiplying single tree estimations by stocking and then totaling these figures. Mean figures are computed by using basal area as weight.

3.4.8. Selection of sample trees

If tally tree data are measurements on individual trees (not tallies by diameter classes), then **ForestCalc** can be used for selection of sample trees (button _Selection of sample trees_). The program asks the desired number of sample trees. Sampling is based on even-distance sampling from cumulative basal area. The principle of the method is as follows:

> _Total sum of basal area of all live tally trees is divided by desired number of sample trees. The result is the sampling interval. The unit is m^2. First sample tree is selected from ½ of interval of cumulative basal area, next trees in every even interval. But if the number of sample trees is 'high' or if there are some extraordinarily big trees among the tree population, this method may give a number of sample trees that is too low. In this case, the missing sample trees are selected randomly from remaining live tally trees._

Trees selected following this basic technique, are marked with yellow background color in the grid and randomly selected trees with red.

3.4.9. Plot locations to MIF-file

If plot's GPS coordinates have been entered, the program can export coordinates of current plot into MapInfo MIF-format file: select _Utilities, Plot location to MapInfo file (.mif)_. For example, if plot number is 15, the program writes output into files _Plot15.mif_ and _Plot15.mid_.

All locations of plots in a region can be exported at a time to map file by selecting _Utilities, All plot locations to mif-file_. The program asks region number, and if for instance region number is 100, then the program writes data into files _Area100.mif_ and _Area100.mid_.

The coordinate system in the output file (MIF-file) can be plane, UTM, or Finnish KKJ-system. The output file consists of plot's border as a polygon, if plot type is rectangular or circular; other plot types are written as point data. Attribute data consist of region number (_Region_) and plot number (_Plot_). **ForestCalc** takes into account the plot's azimuth angle (in case of rectangular plot), if plot's main side's azimuth angle is not equal to zero degrees.

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Figure 17. The program menu (Left). In case of Finnish National Coordinate System, the default zone number is three.

3.4.10. Tree locations, tree map and tree coordinates

The user can measure locations of trees at the plot. Possible methods are the following:

- X- and Y-coordinates are measured (rectangular plot). Plot origin is in the plot's lower left corner (south-west).
- Azimuth and distance are measured from plot's center point, which is plot origin (rectangular, circular, concentric and relascope plot).

Trees must be entered as individual trees, not as number of trees in diameter classes.

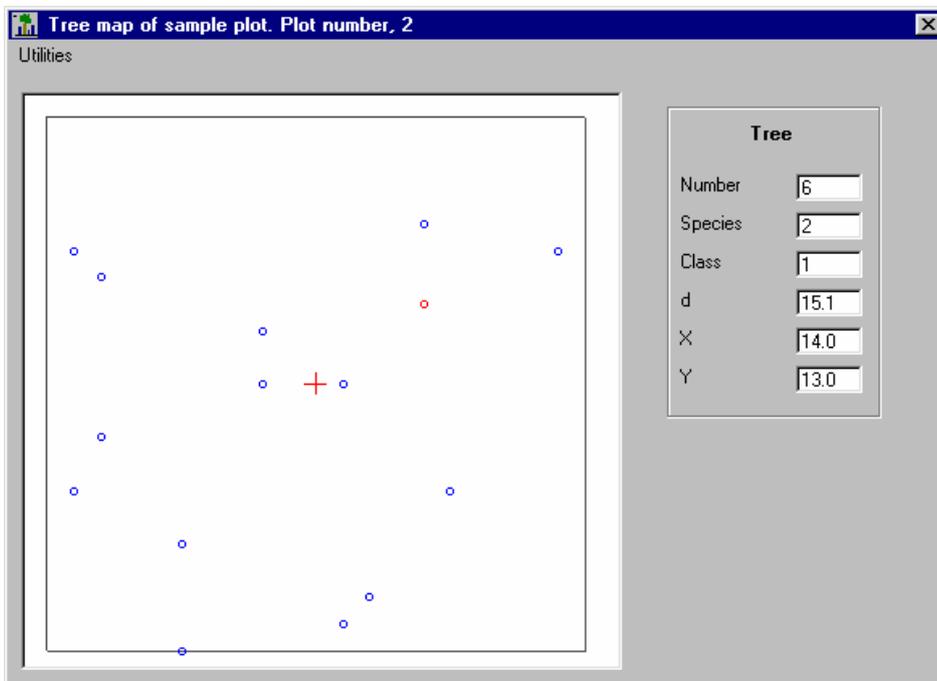**Figure 18.** Plot map with tree locations. Tree data can be viewed by pointing at tree symbol with mouse.

Information about one tree can be viewed by selecting *Utilities, Get tree information*. Mouse pointer becomes a crosshair icon and the tree is selected by clicking left mouse button: selected tree symbol turns red and information is shown in a frame. A click on right mouse causes it to leave pointing mode.

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All tree coordinates of the active plot can be written into an output file by selecting *Utilities, Tree coordinates to file*, either in ArcInfo Generic format or in MapInfo format (MIF and MID files). In ArcInfo Generic format, point file coordinates are written in rows in order of

Tree number, X, Y.

Separator letter is space and last row of this column has text '*END*'.

Before actually writing into the result file, the program asks whether tree coordinates should be written as true geographic coordinates computed with the help of plot GPS data. Figure 19 illustrates this situation.

     Yes   - true coordinates based on the plot coordinates

     No   - plot coordinates based on plot origin (0,0)

     Cancel   - cancel operation

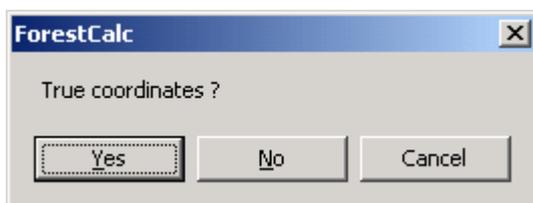**Figure 19.** Selection of tree coordinate output method.

If the plot type is rectangular and the main side azimuth is not equal to zero, and true geographic coordinates are selected, the program writes results corrected with azimuth angle (rotation).

3.5. Compartment estimation

This module is valid only in the Finnish version of the program. All models are specific to Finland only.

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3.6. Timber table

Timber dimensions and prices are stored into parameter file **Treepara.mdb**, table *TimberTable*. This table can be edited in **ForestCalc** main menu, click *Module, Dimensions and prices*.

Dimensions and prices DatabaseEdit

Utilities

Source	Name	Type	Species	MinUpperD	MinLenght	MaxLenght	Division	Value	Value/Tree	Rules
Zambia prices	Bole, CLASS 1	1	14,152,171,	10	1	10	1	10800	10800	
Zambia prices	Bole, CLASS 1	1	26,235,236,	10	1	10	1	18000	18000	
Zambia prices	Bole, CLASS 1	1	15,16,17,18	10	1	10	1	1000	9000	
Zambia prices	Bole, CLASS 1	1	112,113,114	10	1	10	1	1000	14400	
Zambia prices	Bole, CLASS 1	1	117,118	10	1	10	1	1000	12240	
Zambia prices	Bole, CLASS 1	1	131,132,133	10	1	10	1	1000	15840	
Zambia prices	Bole, CLASS 2	1	22,42,59,61	10	1	10	1	1000	7200	
Zambia prices	Bole, CLASS 3	1	1,2,4,5,6,8,1	10	1	10	1	1000	7200	
Zambia prices	Bole, CLASS 3 cont.	1	118,129,162	10	1	10	1	1000	7200	
Zambia prices	Bole, CLASS 3 cont.	1	278,281,288	10	1	10	1	1000	7200	
Zambia prices	Bole other species	1	×	10	1	10	1	1000	7200	
Zambia prices	Pole, 25-30	2	×	10	1	10	1	0	900	AND(d>=25,d<30
Zambia prices	Pole, 20-25	2	×	10	1	10	1	0	540	AND(d>=20,d<25
Zambia prices	Pole, 15-20	2	×	10	1	10	1	0	360	AND(d>=15,d<20

F5	Delete row
F6	Insert row
F7	Add rows to table
F8	Insert row. Copy previous line

Save   Exit

Figure 22. Screen from timber table.

The header columns with yellow background are needed in the computing, however field 'Name' is useful too. Timber prices are in column *Value*, and **the price is per cubic meter in the local currency unit**.

The table includes minimum upper diameters that are used only with taper curves (in Finland), not with the volume equations. However, fill some figures into these fields, too.

The user can give different prices for example for different organizations (*Source*). The maximum number of different groups (Source) is ten.

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Rules for filling this table

Fill first data for Group 1 so that group's name is written similarly on each row. Give prices for the logs/bole (*Type* = 1), then for the pulp/pole wood (*Type* = 2) if applicable. Last, if applicable, give price for the other use wood (such as firewood) (*Type* = 0).

If applicable, next fill data for Group 2, and so on. Groups can present e.g. different timber companies.

Same prices (and dimensions) can be given to more than one species at a time: fill in field *Species* as a list of species codes, where the separator mark is a comma (**,**).

In the computing **ForestCalc** uses the timber table as follows:

Table lookup is always done from top to down.

1) Check 'Group name' -> move down, stop when TRUE
2) Check timber type (1=log/bole, 2=pole, 0=other) -> move down, stop when TRUE
3) Check species list -> move down, stop when TRUE
4) Check diameter rule -> move down, stop when TRUE

If there is no match for certain timber, then it cannot get any monetary value.

Bucking (valid only in Finland)

Log dimensions can be given for each species or/and species groups: fill in minimum upper diameter (over bark), minimum and maximum length and interval in bucking (*Division*). If interval value is zero, the program uses interval of 0.3 meters. Dimensions for pulpwood can be given in a similar way: fill in minimum upper diameter (over bark). Pulp log minimum length is always 2 meters in program. Dimension data for "other use" (class=0) is not used, but price information is used.

3.7. Grid data and statistics

The program uses grid (control) in many screens (see e.g. Figure 22). The following key presses are valid in these grids:

<F5>   Delete row. Active row is deleted.
<F6>   Add row. A new row is added.
<F7>   Add new empty rows to end of table
<F8>   Add a new row and copy all data from the previous row.
<DELETE>   Delete cell value
<BackSpace>   Delete character
<ENTER>   Move to next cell
Ctrl+C   Copy active cell to the clipboard
Shift+Ins, Ctrl+V   Paste

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The user can get statistics from any grid column where there are input data. First, activate the grid (click cursor into it), and then press right mouse button upon the selected column header. If the selected column includes text (characters) in any cell, then the programs computes only number of cases (**N**).
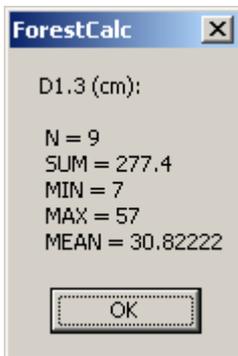

Figure 23. Statistics of selected column.

Any grid data in modules **Sample plot** and **Compartment estimation** can be copied to Windows clipboard with the command *Utilities, Copy table*. The program copies the grid that is currently visible. If no grid is visible, no data are copied to clipboard. This function is practical when the grid data needs to be exported for example to MS Excel.

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4. About application

Copyright and liability

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In some parts of the program, we used RMChart graphics component (http://www.rmchart.com/). Thanks to Mr Rainer Morgen.

In no event shall Tmi LTV Forest be liable for any special, incidental, indirect, or consequential damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or any other pecuniary loss) arising out of the use of or inability to use the software product or the provision of or failure to provide support services, even if Tmi LTV Forest has been advised of the possibility of such damages.

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Background

The program was coded by using Visual Basic^{TM} 6.0. Database structure was created with MS Access^{TM}. Database management was done by using SQL in the code. All texts in the program are written into an ascii file (which is linked into the EXE-file), so that the program can be modified and translated into any new language.

There is a special software for forest inventory data processing, called ForestCalc Inventory. It is also available in Swedish, German, Portuguese, Spanish and Bahasa Indonesia.

Development of the program started in October 1997 and version 1.0 was ready in August 1998. Many persons have given me mental support and ideas for developing this program - especially persons who work in the University of Joensuu. Thank you all! Freeware version was published in spring 2007. The program provider does not give any user support for users of the freeware version.

All comments and feedback are welcome!

       Mr Lauri Vesa
Email: *firstname.lastname @forestcalc.com*
WWW: http://www.forestcalc.com/

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