Manual for matrix initialisation using P_2009

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1. Introduction

This document describes how to generate the initial matrices as input to EFISCEN.

Matrices are generally created with the P_2009 matrix initialisation tool, which is available at: http://www.efi.int/portal/virtual_library/databases/efiscen/model_availability

P_2009 is an update of the P_EFSOS tool that was described previously by Schelhaas et al. (2007). Both versions are still largely the same program as it was delivered to EFI in 1996. The original program (P96) has been adapted to simplify the usage of the program, especially with regard to input handling. The programming language is Fortran (Digital Visual Fortran 6.0).

The functioning of the tool is described using Utopia as an example. Utopia is an imaginary country with forest resources consisting of 1 region, 1 owner, 1 site-class and 1 tree species. The basic input data are shown in Table 1. Age classes are 20 years wide and the first age class includes bare forest land, i.e. forests without trees due to for example clear cut.

Table 1: Basic input data for Utopia.

Age class	Area (ha)	Growing stock (m^3 ha^{-1})	Net annual increment (m^3 ha^{-1} yr^{-1})
0-20	567560	14	1.63
21-40	348815	89	6.88
41-60	165344	158	7.33
61-80	219372	183	6.21
81-100	254784	200	5.32
101-120	142557	199	4.35
121-140	53705	180	3.34
141-160	17692	181	2.76
>160	7663	226	2.55

2 Files and directories

The P-2009 matrix initialisation tool is provided as an executable (P-2009.exe). To use the tool, a number of input files are required and output files are generated (Figure 1). The tool requires several

files and folders to be present in the same directory as the tool itself. Output files will be written to the directory '[path]\output'.

In earlier versions of EFISCEN, P-2009 provided both the initial matrices and the transition chances for the main program. In EFISCEN 4.1, transition chances are calculated in the main program, and thus some of the input and output files for P-2009 have become obsolete.

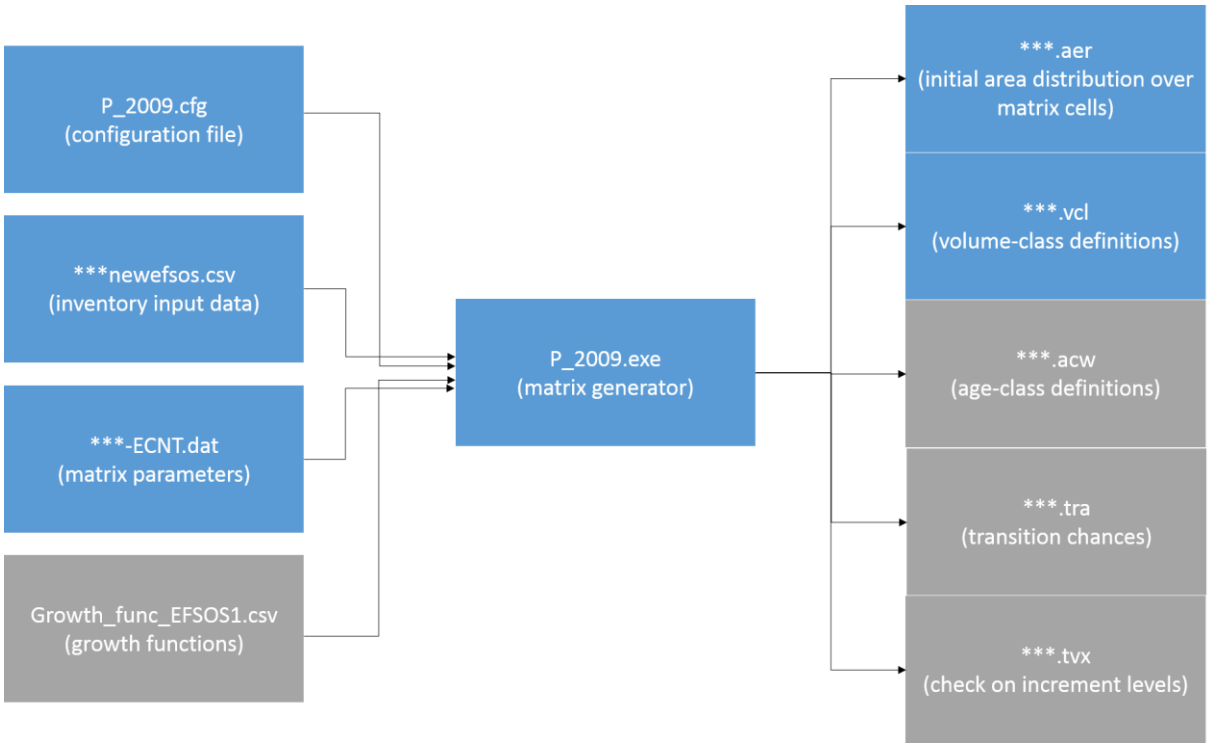

Figure 1: Overview of file structure for the P_2009 tool. Files highlighted in grey are not in active use, but should be present or will be produced.

3 Program inputs

The P-2009 matrix initialisation tool requires the following files and folders to be present in the same directory as the tool itself:

- [path]\p_2009.cfg
- [path]***newefsos.csv
- [path]\Growth_func_EFSOS1.csv
- [path]\ecnt***-ecnt.dat
- [path]\output

The files are explained below, except for the output folder as it does not contain any files needed as input to the tool.

p_2009.cfg

The file p_2009.cfg contains information on the number of regions, owners, site-classes, species, age-classes and volume classes for the country for which matrices need to be generated. The file is a text file with values separated by spaces. An example is shown in Box 1.

```
#P_2009 configuration file
#note: the character '#' in the beginning of the line is used for comments
#order is: LAND NREG NKAT NBON NTRSL NAGE NVOL
#LAND: experiment name
#NREG: number of Regions
#NKAT: number of owners
#NBON: number of site types
#NTRSL: number of species
#NAGE: number of age classes
#NVOL: number of volume classes
# LAND is not case sensitive
uto 1 1 1 1 9 10
#
#END
```

Box 1: example of the configuration file p_2009.cfg, based on data presented for Utopia in Table 1.

*****newefsos.csv**

The file ***newefsos.csv contains the input data tables with the age class structure, area, average volume and current annual increment per age class. This file is easiest generated and edited by Microsoft Excel, using the "save as Comma Separated File" option. For each forest type a table is needed in this file. Missing forest types will be filled with zeros by the model. Each table should be preceded by a line that starts with the word "START" (Box 2). This word tells the program where the next data table starts. Other lines in between the data tables are ignored. The next four numbers indicate the forest type, in the order: Region, Owner class, Site class, Tree species. The order of the data tables within the file is not important. The next number indicates the number of age classes in that data table. However, note that for all matrices the number of age classes should be the same. The last number refers to a growth function in the growth function input file.

The data in the data table are structured as follows:

1. Start age of age class;
2. End age of age class;
3. Area (ha);
4. Average standing volume (m^3 ha^{-1});
5. Net annual increment (m^3 ha^{-1} yr^{-1});

The first age class should include the bare forest land (no trees due to recent clear cut etc.).

```
,
,region,owner class,site class,species,# age classes,growth function
START,1,1,1,1,9,1001
1,20,567560,14,1.63
21,40,348815,89,6.88
41,60,165344,158,7.33
61,80,219372,183,6.21
81,100,254784,200,5.32
101,120,142557,199,4.35
121,140,53705,180,3.34
141,160,17692,181,2.76
161,180,7663,226,2.55
```

Box 2: example of the input data for file ***newefsos.csv, based on data presented for Utopia in Table 1. Only the lines starting with START and the following data tables are read.

Growth_func_EFSOS1.csv

This file contains the parameter values for the growth functions. Although this file is still needed to run P-2009, it has no function anymore. All the numbers of the growth functions that are used in the ***newefsos.csv file should be present in this file as well. Easiest is therefore to take an existing growth function and use only that one. The growth functions are defined by the three parameters a_0, a_1 and a_2 (Equation 5). The file structure is shown in Box 3. The first lines can be used for comments. The data lines start with the number of the growth function, followed by the parameter values. The rest of the line can be used to identify where the growth function should be applied, or on which data it is developed. This part is not read by the tool.

```
expla:,country Utopia
expla:
expla:,a0,a1,a2,,country,regions,owners,spp
1001,-2.0384,1604.33,-10256,,Uto,Somewhere,Someone,Pine
```

Box 3: example of the growth functions file Growth_func_EFSOS1.csv, based on data presented for Utopia in Table 1.

******-ecnt.dat***

The ***-ecnt.dat file contains the parameters that are needed for the matrix set-up and the distribution of the area. The first line should start with 2002 (see Figure 4.5). This distinguishes the P-2009 ecnt file from those that were used with P96. Each line contains the parameters for one forest type (defined by the last four digits). The order of the parameters is cv, r, VCW_1 and Beta (see Schelhaas et al. 2007 for explanation of the parameters). The VCW_1 parameter defines the width of the first volume class. During the execution this value can be adapted if needed. The Beta parameter is redundant, since transitions due to increment are now calculated in the main executable. After execution of P_efsos.exe, the ecnt file will be overwritten. The new file will contain the new VCW_1 parameter. It might therefore be good to make a back-up of the ecnt file with parameter values that produced good results. The order of forest types should be the same as in the inventory data file (i.e. the file ***newefsos.csv).

```
  2009 version
  0.65  0.50  55.00  0.4000   1   1   1   1
```

Box 4: example of the ***-ecnt.dat file, showing the parameters cv, r, VCW_1 and Beta for the forest types defined by region, owner class, site class and tree species, based on data presented for Utopia in Table 1.

4 Program execution

P-2009 can be executed directly from Windows, but we advise to run the tool using the MS-DOS command prompt. In this way, error messages can be read by the user.

To start the tool, navigate to the folder where P_2009.exe is located. Then call the programme and provide the country code for which matrices need to be generated. In the case of Utopia the command is as follows (note: the tool is case-sensitive):

```
P_2009.exe uto
```

Next, the user needs to answer several questions:

1. ARE YOU GOING TO CHANGE X1 DURING THIS RUN?
   X1 is the old name for the width of the first volume class (now called: VCW_1). If Yes (1) is answered, the user will have to go through all forest types of that country and either agree with the chosen value or to propose another one. If No (0) is answered, the values from the parameter file (***-ecnt.dat) will be used.

2. TREAT STRUCTURE 1?
   This question is always answered by Yes (1). Answering with No (0) will terminate the program.

3. MAGE=NAGE?
   NAGE is the number of age classes in the input data and MAGE is the number of age classes that is taken into account during the matrix initialisation. This question is also always answered with Yes (1). If No (0) is answered, the program will ask "NEW MAGE ?", which is the number of age classes you want to be included in the output. The maximum that can be entered here is the number of age classes in the input data. If the number of age classes in the input data is 9 and a value for MAGE of 6 is entered, only the first six age classes will be used. This will result in a smaller initial matrix (less age classes), but also the width of the volume classes may be affected, as well as the distribution over the matrix per age class.

After answering these questions, a whole block with information will appear (Figure 2). The first line defines which forest type is currently being treated. The next block is not relevant for the average user.

The line "X0 X1 X2 (etcetera)" defines the different volume classes, where X0 is the bare forest land class, X1 the first volume class, etc. The second line shows the upper limits of the volume classes. The third line specifies which percentage of the total area of the forest type is placed in which volume class, with the current parameter settings. This information can be used to decide if one would like to change the width of the first volume class (VCW_1). For example, with very low values for VCW_1, negative values may appear.

The next few lines are not of interest (they show information about the increment). The last two lines show the average volume per age class from the input data (ING VOL) and the average volume as calculated from the area distribution over the volume classes.

The program then asks if you would like to change the value of VCW_1 (X1). A "1" means that the current value is accepted; otherwise a new value can be entered. If all forest types have been treated, the program will terminate.

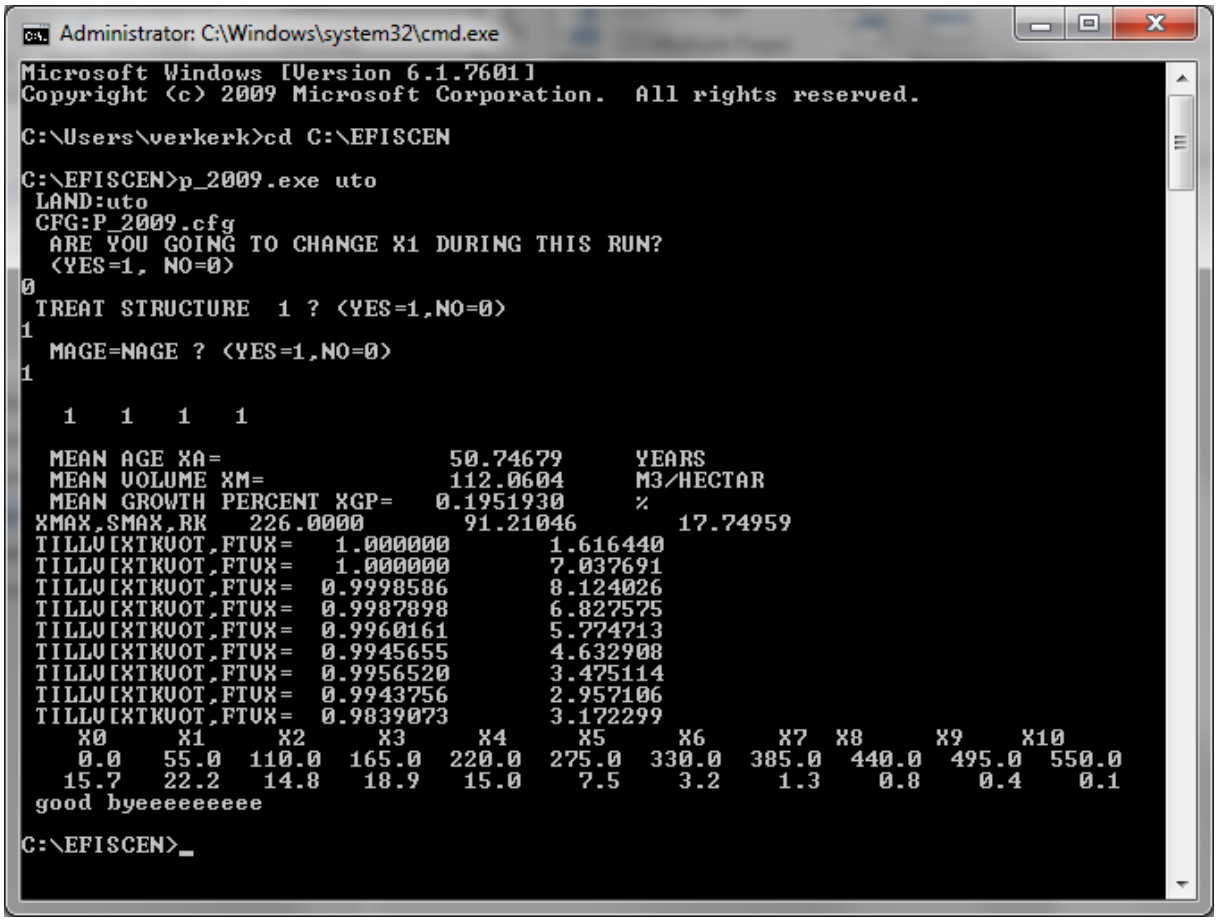

Figure 2: screenshot after running P_2009.exe for Utopia.

Some guidelines for the choice of VCW_1 have been developed in the past. These were merely meant to standardize choices between users; a scientific background is usually lacking. The following guidelines generally apply:

1. Start with a low VCW_1
2. Look at highest volume class and divide by 10 for new VCW_1
3. If the share of bare forest land class is higher than 8%, divide VCW_1 by 2
4. After finishing, re-run P-2009 without changing VCW_1 (this is needed to enable automatic adaptation of VCW_1 as described above)
5. Check for negative area in the *.aer file and adapt VCW_1 where needed

One drawback of the program is that negative values are permitted. The user should therefore manually check the ***.aer file for negative values, and adapt the VCW_1 for those forest types.

A few special situations might occur, which generally only occur in situations when the input data are highly disaggregated.

- If the average volume in the second age class is lower than or equal to one, it is set to 0.75 times the volume of the first age class. If that volume is also lower than or equal to zero, the volume in the second age class is set to 1 m^3/ha. In both cases VCW_1 will automatically be set to 1.3 m^3/ha. This can be overruled by entering a new VCW_1 manually. However, when P-2009 is ran later, VCW_1 will automatically be adapted again.
- If the average volume in the second age class of the inventory data is lower than the average volume in the first volume class (defined by VCW_1), VCW_1 will be set to 1.3 times the volume in the second age class. This can be overruled by entering a new VCW_1 manually. However, when P-2009 is ran later, VCW_1 will automatically be adapted again.
- If the average volume of the inventory data in a higher age class of the inventory data is lower than the average volume in the first volume class (defined by VCW_1), nothing will be changed. All area will be in the first volume class, but average volume will be overestimated for that age class.
- If the average volume of the inventory data in a higher age class is equal to or lower than one, it is internally replaced by 0.75 times the value of the first preceding age class where a value higher than 1 is given.

As a general rule, the user should consider to aggregate data to a higher level if average volume data are missing for many age classes, or if they appear very irregular.

5 Program outputs

******.log***

In the main directory, a file ***.log will appear. This file contains many messages that are generated during the execution of the program. This file has been used by the developers and is not relevant for the average user.

******.acw***

The output file ***.acw is redundant. It contains information about the age class width. The first column is the width of the age-class; the second column is the average age.

******.aer***

The file ***.aer contains the area distribution over the matrix for each forest type. Forest types are defined by the indices for region, owner class, site class and tree species (Box 5). Columns are age classes and rows are volume classes. The first column of the first row represents the bare land class. The second row represents the first volume class, the third row the second volume class, etc.

```
#EFISCEN3 input file
#volume classes in file:
uto.vcl
#First how many
1
# REG OWNER SITE SPECIES
   1   1   1   1
   278.620     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
   288.940   103.751     1.680     0.000     0.000     0.000     0.227     0.099     0.000
     0.000   136.506    42.159    34.534    21.030    14.312    11.360     3.801     0.061
     0.000    72.462    57.128    67.990    75.000    41.405    15.060     4.829     2.038
     0.000    35.776    38.330    60.770    73.764    39.362    12.894     4.166     2.059
     0.000     0.320    15.942    33.187    47.153    25.563     7.656     2.535     1.649
```

```
    0.000    0.000    5.322   12.554   21.322   12.093    3.405    1.174    0.973
    0.000    0.000    3.189    5.271    7.907    4.615    1.389    0.480    0.442
    0.000    0.000    1.337    3.462    4.804    2.699    0.923    0.308    0.189
    0.000    0.000    0.233    1.340    2.791    1.733    0.557    0.201    0.127
    0.000    0.000    0.023    0.265    1.015    0.775    0.234    0.100    0.123
```

Box 5: Example of the file ***.aer, based on data presented for Utopia in Table 1. The area distribution is shown as generated by P_2009 (1000 ha).

.vcl

The file ***.vcl contains information about the volume classes. For each forest type, the upper limits of the volume classes are shown (Box 6).

```
#EFISCEN3 input file
#First how many
1
# REG OWNER SITE SPECIES
   1   1   1   1
       55.
      110.
      165.
      220.
      275.
      330.
      385.
      440.
      495.
      550.
```

Box 6: Example of the file ***.vcl, based on data presented for Utopia in Table 1. The upper limits of the volume classes are shown for each forest type in m^3 ha^{-1}.

.tvx

The file ***.tvx contains information about the current annual increment in each cell of the matrix. This file is not in use anymore.

.tra

The file ***.tra contains the transition chances for each cell of the matrix. This file is not in use anymore.

6 Further processing

The ***.aer and ***.vcl are the main outputs of P_2009, which will be used by EFISCEN.

In addition to the information in these two files, EFISCEN requires input on *age classes of volume series* and *optimal growing stock per age class* in EFISCEN's parameter file (see Verkerk et al. 2016 for details). This input can be extracted from the ***newefsos.csv file using the volume series tool (volseries.exe), which is available at:
http://www.efi.int/portal/virtual_library/databases/efiscen/model_availability

The volume series tool needs to be located in the same folder as the ***newefsos.csv file. To start the tool, navigate to the folder where volseries.exe is located. Then call the programme and provide the name of the ***newefsos.csv file (Figure 3).

In the case of Utopia, the command is as follows (note: the tool is case-sensitive):

```
volseries.exe UTOnewefsos.csv
```

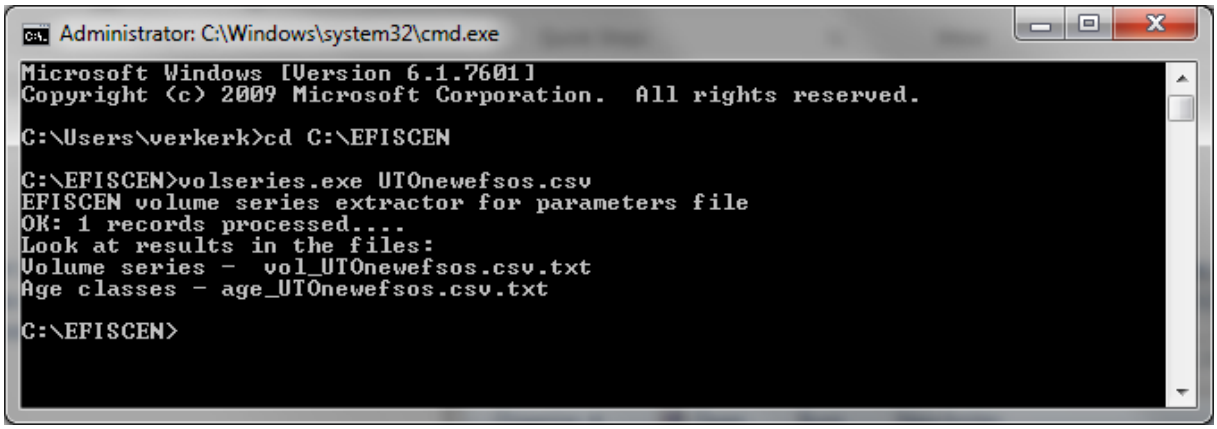

Figure 3: screenshot after running volseries.exe for Utopia.

Two text files are generated (age_***newefsos.csv.txt and vol_UTOnewefsos.csv.txt), which contain the *age classes of volume series* and *optimal growing stock per age class* to be used in EFISCEN's parameter file.

References

Schelhaas M.J., Eggers J., Lindner M., Nabuurs G.J., Päivinen R., Schuck A., Verkerk P.J., Werf, D.C. van der, Zudin S., 2007. Model documentation for the European Forest Information Scenario model (EFISCEN 3.1.3). Alterra report 1559 and EFI technical report 26. Alterra and European Forest Institute, Wageningen and Joensuu. 118 pp.

Verkerk P.J., Schelhaas M.J., Immonen V., Hengeveld G., Kiljunen J., Lindner M., Nabuurs G.J., Suominen T., Zudin S., 2016. Manual for the European Forest Information Scenario model (EFISCEN 4.1). EFI Technical Report 99. European Forest Institute, Joensuu.