Sub-Regional Timber Supply Model (SRTS) User Guide & Documentation

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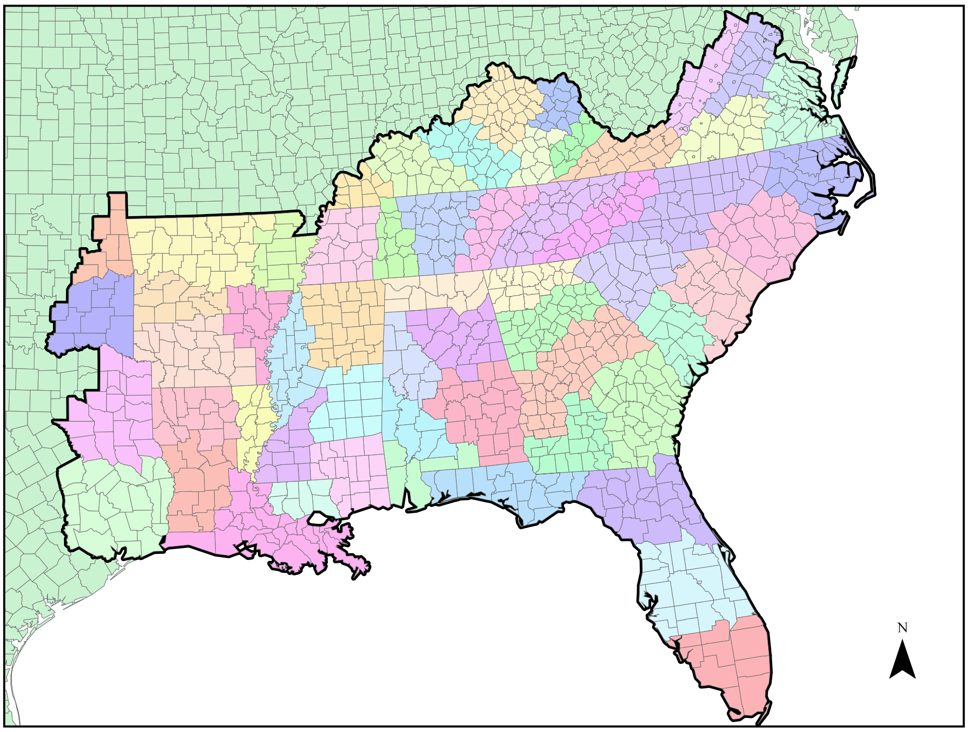
Running SRTS

1.1 Introduction

SRTS is an economic model of timber supply based on detailed, empirical US Forest Service Forest Inventory and Analysis (FIA) data. From these data we are able extract forest inventory, removals and biological factors for custom sub-regions that are important to a model client. The flexibility of regional scope makes SRTS applicable to analyzing a variety of problems: from broader policy and sustainability questions to analysis of a small timber basin. The maximum regional extent of the model is the US Southeast (see the figure below). As a model of timber supply in stumpage markets only, it is up to the user to specify demand projections. Procedures to ensure the correct starting point for a demand projection are discussed below. For a detailed review of how the model works, see Projecting southern timber supply for multiple products by subregion (Abt, Abt & Cubbage, 2009), available in the SRTS Documentation folder.

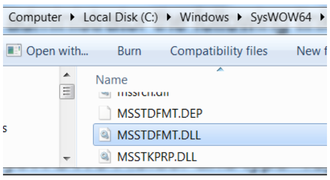


1.2 Installation

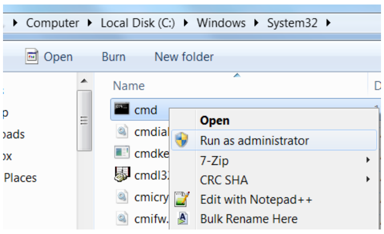
SRTS is a standalone executable written in the Visual Basic programming language. As such, it does not require installation with an installer package. However, some steps need to be taken to ensure proper functionality on 64-bit operating systems. SRTS is compatible with computers running a Windows operating system. Computers running other operating systems have shown mixed compatibility, and support is not guaranteed for those systems.

To apply the *fix* for 64-bit machines, take the following steps:

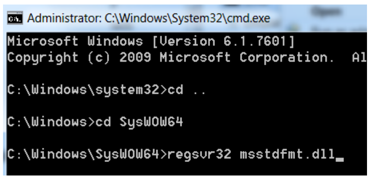
1. Navigate to the Documentation > 64-bit Installation folder.
2. Copy the *MSSTDFMT.DLL* file to the directory: C:\Windows\SysWOW64\



3. Open cmd.exe as administrator (right-click, *Run as administrator*)



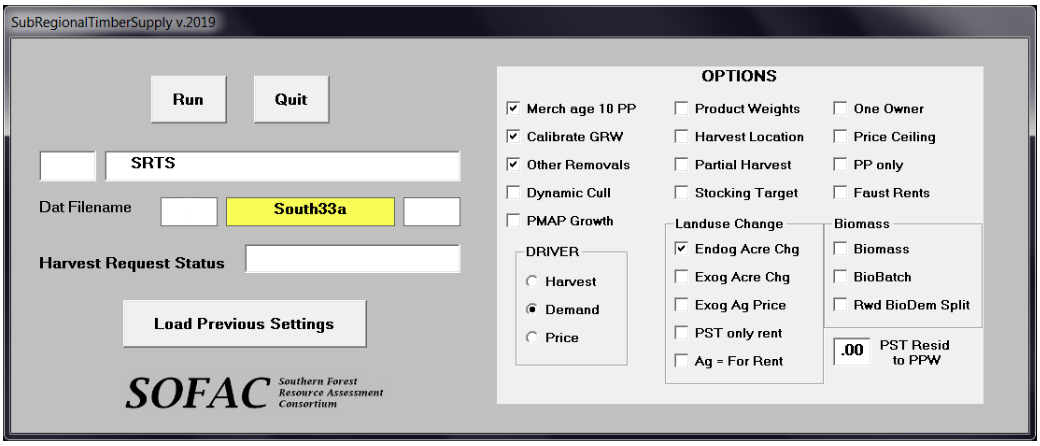
4. Change directories to Windows\SysWOW64 folder and register the DLL:
   - Type ”cd ..” and hit Enter.
   - Type ”cd SysWOW64” and hit Enter.
   - Type ”regsvr32 msstdfmt.dll”, hit Enter.



1.3 Running the Model–A Brief Tutorial

The SRTS Distribution comes pre-configured to run a southwide and state-level analyses. To make your first SRTS run, follow these steps.

1. If you have not already read the preceding *Installation* section, do so now to ensure compatibility of SRTS with your computer.
2. Double-click the SRTS executible in the main SRTS directory: srts_mmddyy. The user interface shown below should appear.



3. Click 'Run' and the model should successfully make a run based on a DAT file with the name highlighted in yellow above (i.e. South33a.DAT). Note: A 'Not Responding' message in the user interface is nothing to be concerned about.

4. After the model run is complete, the word 'END' will appear on the user interface. Several output files will also appear in the same folder as the SRTS executable.

5. To close SRTS, you must click the 'Quit' button.

After completing the preceeding steps, you have technically completed a SRTS run. The remainder of the process is understanding the purpose of the assorted input files. The remaining documentation discusses the purpose and format of each input and output file. To complete the basic tutorial, however, the following outlines the basic order of preparation for running the model.

1. Identify a region of interest and submit a basin request
   - (a) Arrange a comma-delimeted 'basin request' file as described in Chapter 2, section 2. Submit this csv file by email to jessedhenderson@gmail.com to obtain an inventory file with differentiated ownership (corporate and non-corporate).
   - (b) The basin request must include a minimum of 5 to 8 counties per sub-region for compliance with an MOU.
   - (c) Optionally request a History (.Hist) file showing historical merchantable volume.
   - (d) Alternatively create your own inventory file for 'One-owner mode' runs using the INVmaker.exe located in the Data folder.

2. Set up your DAT file
   - (a) Following an included DAT file template and consulting the section describing the DAT file, create the DAT file for your run.
   - (b) Use 'MPCONST.PRJ' for your demand projection in this initial construction.
   - (c) Insure that other input files listed in the DAT file are located in the Data folder.
   - (d) Alternatively use the DATmaker.exe to create DAT files and PRD files.

3. Make a run with your DAT file
   - (a) After the run is complete, locate MPCONST.PRJ in the Data folder, and open it to edit the file in Excel.
   - (b) Leave year 0 removals by product unchanged.
   - (c) Change consecutive years to match your anticipated demand projection.
   - (d) Save your custom PRJ file in the Data Folder

4. Prepare other input files
   (a) Revise your DAT file by renaming the PRJ file to match your custom PRJ file saved in the last step.
   (b) Create additional input files as required for selected model options if necessary.
5. Make your final run
   (a) Run SRTS with your DAT file
   (b) Examine the output files of interest. The main output file is the GPG file.

1.4 File Structure

The basic SRTS file structure is organized in the following manner:

SRTS folder

1. Data (folder)
   (a) INVmaker (executable)
   (b) Various required files
   (c) PRD, INV, PRJ, DBH files
2. Documentation (folder)
3. Figures (folder)
4. CarbonWelfare2019 (executable)
5. DATmaker (executable)
6. FigureSRTS (R file)
7. SRTS_mmddyy (executable)
8. DAT files
9. All Output files

1.5 Input Files and Model Options

Input files needed to run the model are typically space or comma delimited text files with custom file extensions (e.g. DAT, PRD, INV). To view or edit input files, it is useful to download and install a text editor program like Notepad++ or Wordpad. Right-click the input file and *Open With...* your chosen text editor program. Template files included with the SRTS distribution and this documentation can be used to produce needed input files. Alternatively, you may use DATmaker to create DAT and PRD files. Inventory (INV) files are not created manually by the user.

1.5.1 Main Configuration File – *.DAT

This section of the document gives a line by line description of the *.DAT* file and a general description of associated input files. The *.DAT* file is the run configuration file. This is the file that identifies the parameters and input files for the run. The name of this file is the only input required on the SRTS input screen. The input screen simply concatenates the three *DAT Filename* textboxes shown on the SRTS screen and looks for the *.DAT* file extension in the folder where the SRTS application is located. For example, the screen below instructs SRTS to read the configuration file *AL.DAT*. This name is not case sensitive. All of the information required for a basic run is in this file. The user hits the RUN button and at the end of the run either quits or enters a new DAT file name.

```
1 AL
2 "stand4_default.PRD" "MPCONST.PRJ" "dbhagepine31a_gsp2.TXT"  "AL_gs.csv" "AL"
3 6 4 2012 51 1
4 1  "AL-SW_S"   2  "AL-SW_N"   3   "AL-SE    "  4 "AL-WCtrl" 5  "AL-NCtrl"  6 "AL-North"
5 .3 .3 .3 .3
6 .3 .5 .3 .5
7 1 1 .7 .7
8 .3 .5 .3 .5
9 1 1 .7 .7
```

Saving the DAT file from a run gives a summary of all of the input filenames, output filenames, regions, and elasticities. After the run a YourRunID.INI file is created that shows all of the menu settings from that run. The YourOutputFilename.DSC output file described in OutputFiles.PDF gives a full description of the run.

By default SRTS starts with the DAT file and settings from the last run made. If you put in a DAT filename from a previous run and then push the "Load Previous Settings" button, the previous settings associated with that DAT file run are loaded. Note that this requires that the previous run was done with SRTS 3.9 or later, which creates an ".INI" file for every run. You can then enter a new DAT filename and retain the settings from the previous run.

DAT File Contents

The DAT file is read in list format, so line numbers aren't important as long as the data is in the expected order. Still, organizing a DAT file by lines is useful for troubleshooting and explaining the sections. The following descriptions reference the line numbers in the preceding example DAT file.

Run Description (Line 1):

```
1 AL
2 "stand4_default.PRD" "MPCONST.PRJ" "dbhagepine31a_gsp2.TXT"  "AL_gs.csv" "AL"
3 6 4 2012 51 1
4 1  "AL-SW_S"   2  "AL-SW_N"   3   "AL-SE    "  4 "AL-WCtrl" 5  "AL-NCtrl"  6 "AL-North"
5 .3 .3 .3 .3
6 .3 .5 .3 .5
7 1 1 .7 .7
8 .3 .5 .3 .5
9 1 1 .7 .7
```

This is an optional line to describe the run. If the program sees "PRJ" and "PRD" on this line, it assumes you don't have a Run Description line.

File Names (Line 2):

```
1 AL
2 "stand4_default.PRD" "MPCONST.PRJ" "dbhagepine31a_gsp2.TXT"  "AL_gs.csv" "AL"
3 6 4 2012 51 1
4 1  "AL-SW_S"   2  "AL-SW_N"   3   "AL-SE    "  4 "AL-WCtrl" 5  "AL-NCtrl"  6 "AL-North"
5 .3 .3 .3 .3
6 .3 .5 .3 .5
7 1 1 .7 .7
8 .3 .5 .3 .5
9 1 1 .7 .7
```

This line name four files that must be located in your "SRTS XXx/Data/" folder, followed by an output file name of your choice – a total of five terms. When this example DAT file is run by SRTS, the four files must be present to avoid errors. Typos are a common mistake related to this line. When SRTS runs successfully, the output files are produced in the same folder as the DAT file, and they will all be named according to your chosen output file name. Acronyms for the file types are explained below, and a full description of the file contents are described in later sections.

1. PRD Product Definition File
2. PRJ Harvest Projection File
3. DBH.TXT Diameter Distribution File (diameter at breast height)
4. INV Summarized FIA Inventory Data
5. OUTPUT Filename to be used for output files

Run Parameters (Line 3):

```
1 AL
2 "stand4_default.PRD" "MPCONST.PRJ" "dbhagepine31a_gsp2.TXT"  "AL_gs.csv" "AL"
3 6 4 2012 51 1
4 1  "AL-SW_S"   2  "AL-SW_N"   3   "AL-SE    "  4 "AL-WCtrl" 5  "AL-NCtrl"  6 "AL-North"
5 .3 .3 .3 .3
6 .3 .5 .3 .5
7 1 1 .7 .7
8 .3 .5 .3 .5
9 1 1 .7 .7
```

These are parameters for the run. Certain parameters must be consistent with the files listed on line 2 or internally consistent with the DAT file. Check these consistencies to troubleshoot, especially if you get "subscript out of range" errors. Here is a description of each parameters meaning along with places to check for consistency:

Parameter	Meaning	Check for Consistency
51	Number of regions	SRTS Region Numbers & Labels
4	Number of products	PRD file, custom PRJ file columns
2017	Starting Year	Average re-measurement date for INV
30	Number of years to project	Custom PRJ file row index
1	Interval (years) between detailed reports	None

SRTS Region Numbers and Region Labels (Line 4):

```
1 AL
2 "stand4_default.PRD" "MPCONST.PRJ" "dbhagepine31a_gsp2.TXT"  "AL_gs.csv" "AL"
3 6 4 2012 51 1
4 1  "AL-SW_S"   2  "AL-SW_N"   3   "AL-SE    "  4 "AL-WCtrl" 5  "AL-NCtrl"  6 "AL-North"
5 .3 .3 .3 .3
6 .3 .5 .3 .5
7 1 1 .7 .7
8 .3 .5 .3 .5
9 1 1 .7 .7
```

This section follows a format with a SRTS Region Number followed by a Region Label in quotes. The SRTS Region Numbers are specific to these survey units. They are keyed to the quotes. The SRTS Region Numbers are specific to these survey units. They are keyed to the "stateunitphyky.txt" file located in the Data folder, which allows the program to match DBH distributions to sections (Southeast or South Central) and physiographic regions. Refer to the Southwide input file or the "SRTS_REGION_LOOKUP.xls" worksheet to select the appropriate SRTS number for any subregion. Alternatively, you can use the DATmaker executable to automatically determine the SRTS

Region Number that fits a custom basin, based on the survey unit that most of the counties fall in. If you were running just one basin in SE Georgia, for example, you would use SRTS Region Number 16 to key the program to the right diameter distribution. These numbers do not have to be unique; all of the basins in a run could use the same number.

Region Labels are used in the output reports. The order of these regions in the DAT file must match the order of the data in the INV data file.

Elasticities

Following the regions and labels listing, we list elasticities by product. The number of elasticity measures in each category described below must match the number of products specified on Line 2, and product order must match the product definition file. If the run uses one-owner mode, Lines 19 and 20 should be omitted from the DAT file.

Demand Price Elasticities by Product (Line 5):

```
1 AL
2 "stand4_default.PRD" "MPCONST.PRJ" "dbhagepine31a_gsp2.TXT"  "AL_gs.csv" "AL"
3 6 4 2012 51 1
4 1  "AL-SW_S"   2  "AL-SW_N"   3   "AL-SE    "  4 "AL-WCtrl" 5  "AL-NCtrl"   6 "AL-North"
5 .3 .3 .3 .3
6 .3 .5 .3 .5
7 1 1 .7 .7
8 .3 .5 .3 .5
9 1 1 .7 .7
```

The percent change in quantity of stumpage demanded from a percent change in stumpage price. For example, .3 means that a 1% change in price would lower demand by .3%. In harvest driven runs, these numbers don't matter because the model is solving for the price that would be required to meet the requested harvest given what is happening to inventory. In a demand driven run, the demand elasticity dictates the sensitivity of harvest to price.

Supply Price Elasticities by Product for Industrial/Corporate Owners (Line 6)

```
1 AL
2 "stand4_default.PRD" "MPCONST.PRJ" "dbhagepine31a_gsp2.TXT"  "AL_gs.csv" "AL"
3 6 4 2012 51 1
4 1  "AL-SW_S"   2  "AL-SW_N"   3   "AL-SE    "  4 "AL-WCtrl" 5  "AL-NCtrl"   6 "AL-North"
5 .3 .3 .3 .3
6 .3 .5 .3 .5
7 1 1 .7 .7
8 .3 .5 .3 .5
9 1 1 .7 .7
```

The percent change in quantity of stumpage supplied from this ownership induced by a percent change in stumpage price. For example, .5 means that a 1% change in price would increase harvest by .5% other thing being equal. These numbers have a direct effect on the price required to achieve a given harvest. There must be as many entries here as there are products.

Supply Inventory Elasticities by Product for Corporate Owners (Line 7):

```
1 AL
2 "stand4_default.PRD" "MPCONST.PRJ" "dbhagepine31a_gsp2.TXT"  "AL_gs.csv" "AL"
3 6 4 2012 51 1
4 1  "AL-SW_S"   2  "AL-SW_N"   3   "AL-SE    "  4 "AL-WCtrl" 5  "AL-NCtrl"   6 "AL-North"
5 .3 .3 .3 .3
6 .3 .5 .3 .5
7 1 1 .7 .7
8 .3 .5 .3 .5
9 1 1 .7 .7
```

The percent change in quantity of stumpage supplied from this ownership induced by a percent change in product inventory. For example, 1 means that a 1% change in inventory would increase harvest by 1% other things being equal. These numbers have a direct effect on the price required to achieve a given harvest. There must be as many entries here as there are products. The .7 above for hardwoods implies that if total hardwood inventor goes up by 1%, the timber supply only goes up by .7% to reflect availability restrictions for hardwoods.

Supply Price Elasticities By Product for Non-Corporate Owners (Line 8):

```
1 AL
2 "stand4_default.PRD" "MPCONST.PRJ" "dbhagepine31a_gsp2.TXT"  "AL_gs.csv" "AL"
3 6 4 2012 51 1
4 1  "AL-SW_S"   2  "AL-SW_N"   3   "AL-SE    "  4 "AL-WCtrl" 5  "AL-NCtrl"  6 "AL-North"
5 .3 .3 .3 .3
6 .3 .5 .3 .5
7 1 1 .7 .7
8 .3 .5 .3 .5
9 1 1 .7 .7
```

This entry characterizes Non-Corporate Owners and is analogous to Line 6.

Supply Inventory Elasticities By Product for Non-Corporate Owners (Line 9):

```
1 AL
2 "stand4_default.PRD" "MPCONST.PRJ" "dbhagepine31a_gsp2.TXT"  "AL_gs.csv" "AL"
3 6 4 2012 51 1
4 1  "AL-SW_S"   2  "AL-SW_N"   3   "AL-SE    "  4 "AL-WCtrl" 5  "AL-NCtrl"  6 "AL-North"
5 .3 .3 .3 .3
6 .3 .5 .3 .5
7 1 1 .7 .7
8 .3 .5 .3 .5
9 1 1 .7 .7
```

This entry characterizes Non-Corporate Owners and is analogous to Line 7.

1.5.2 Product Definition File – * *.PRD

Example File *"stand4default.PRD"*

```
SP PR PROD LABEL  MINDBH PCTPULP WGTFACTOR
1  1   "SmRwd"    1        1.0    35.5
1  2   "LgRwd"    3       .15
2  1   "SmRwd"    1        1.0    37
2  2   "LgRwd"    4        .3
```

The product definition file is where the merchandizing rules are summarized. The first column is the species group. If there are 2 species groups they are assumed to be pine and hardwood. If there are 3 species groups they are assumed to be pine, soft hardwood, and hard hardwood. Within each product group, products are listed in order from smallest diameter to largest and assigned an index for the product (PR) column. In this case there are 2 pine products and 2 hardwood products. The third column gives the product label. These can be 8 characters long, but should be unique in the first 4 characters because some output files truncate this label.

Column four gives the minimum diameter at breast height (MINDBH) for the product. The standard DBH distribution file (described below) using the standard 2-inch dbh classes starting with 5 inches. In the MinDBH column you list the minimum dbh class that qualifies for this product. The PctPulp columns indicates how much of this product class should be considered pulpwood. The fifth column gives a weight conversion factor by species. All of the input data is in thousands of cubic feet (MCF). Output is multiplied by the WGTFACTOR for each species group just before it is written to the output file. The weights above convert the output units to green tons. If you entered a *1* here, output would be reported in MCF.

1.5.3 Demand Projection File – *.PRJ

The harvest projection file (PRJ) is an optional file to describe the harvest projection by product. If in the DAT file, the name "MPCONST.PRJ" is used as the filename for the demand projection, the model will project year zero removals by product for the entirety of the model run. The "MPCONST.PRJ" file will be created during the run.

The output units are in thousand cubic feet (MCF) and the product order is determined by the PRD file. The first column is the projection year; the second is harvest of product 1 in MCF, and so forth.

Custom harvest trends, for example a 1% increase for 5 years before flattening off, can be created by importing this file into Excel and editing appropriately. Save the file with some name other the "MPCONST.PRJ", specify this name as the harvest projection file in the DAT file, and SRTS will use that harvest trend and ignore the harvest parameters in the DAT file. Do NOT change line "0" since this reflects the starting point of the FIA data in the INV file.

1.5.4 Diameter Distribution File – *.DBHtxt

SRTS currently works with 5 year age classes. The diameter distribution file contains the diameter distribution across the nine 2" dbh classes, starting with 5-6.9" and ending with 19+".

Column	Variable	Codes
1	Station	1 = Southeast, 2 = South Central
2	Physiographic Region	1 = Coastal Plain, 2 = Delta, 3 = Mountain, 4 = Piedmont
3	Owner	1 = Industrial/Corp, 2= Non-Industrial/Corp., 3= Total Private
4	Species Group	1 = Pine, 2 = Hardwood, 3 = Soft Hardwood, 4 = Hard Hardwood
5	Mgt Type	1 = Plantation, 2 = Nat Pine, 3 = Mix Pine, 4 = Upl Hwd, 5 = Lowl Hwd
6	Age Class	4 = 15-19, 5 = 20-24, 6 = 25-29, ...
7	Dbh Class	1 = [5"-7"), 2 = [7"-9"), ... (custom dbh class definitions are possible)
8	Proportion of Volume in DBH Class	Continuous Number

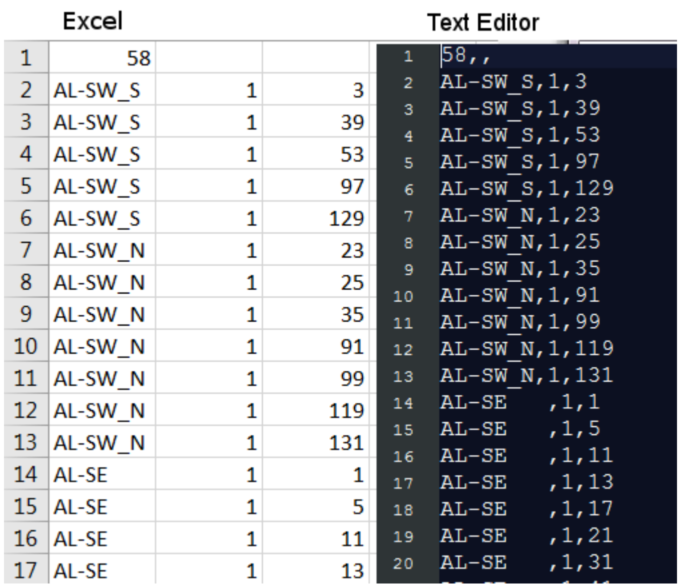
1.5.5 Inventory File – *.INV *or* *.csv

The INV file is the starting inventory, growth, removal and acreage data for the run, summarized from FIA data. The following table identifies the variables by column for the file.

Column	Variable	Codes/Meaning
1	State or Basin Number	NA
2	Sub-Region Number	Ordered by basin request
3	Owner	1 = Industrial/Corp, 2= Non-Industrial/Corp., 3= Total Private
4	Mgt Type	1 = Plantation, 2 = Nat Pine, 3 = Mix Pine, 4 = Upl Hwd, 5 = Lowl Hwd
5	Species Group	1 = Pine, 2 = Hardwood, 3 = Soft Hardwood, 4 = Hard Hardwood
6	Age Class	4 = 15-19, 5 = 20-24, 6 = 25-29, ...
7	Growing Stock	Inventory in MCF
8	Cell GPA	Actual FIA growth/acre for the unit in cubic feet per acre per year
9	Regressed GPA	Smoothed growth/acre
10	Removals	Removals in MCF[1]
11	Growing Stock	Inventory in MCF
12	Growing Stock	Inventory in MCF
13	Acres	Inventory in MCF

Making a Basin Request

Before running SRTS, a region of interest must be specified. A region, represented by a list of state and county FIPS codes, is used to construct an inventory (INV) file. The Southern Forest Resource Assessment Consortium (SOFAC) produces INV files based on basin requests. Model users submit a CSV file (preferred) or Excel file by email, arranged in the following manner:

[H] 

Excel

1	58		
2	AL-SW_S	1	3
3	AL-SW_S	1	39
4	AL-SW_S	1	53
5	AL-SW_S	1	97
6	AL-SW_S	1	129
7	AL-SW_N	1	23
8	AL-SW_N	1	25
9	AL-SW_N	1	35
10	AL-SW_N	1	91
11	AL-SW_N	1	99
12	AL-SW_N	1	119
13	AL-SW_N	1	131
14	AL-SE	1	1
15	AL-SE	1	5
16	AL-SE	1	11
17	AL-SE	1	13

Text Editor

```
1  58,,
2  AL-SW_S,1,3
3  AL-SW_S,1,39
4  AL-SW_S,1,53
5  AL-SW_S,1,97
6  AL-SW_S,1,129
7  AL-SW_N,1,23
8  AL-SW_N,1,25
9  AL-SW_N,1,35
10 AL-SW_N,1,91
11 AL-SW_N,1,99
12 AL-SW_N,1,119
13 AL-SW_N,1,131
14 AL-SE   ,1,1
15 AL-SE   ,1,5
16 AL-SE   ,1,11
17 AL-SE   ,1,13
18 AL-SE   ,1,17
19 AL-SE   ,1,21
20 AL-SE   ,1,31
```

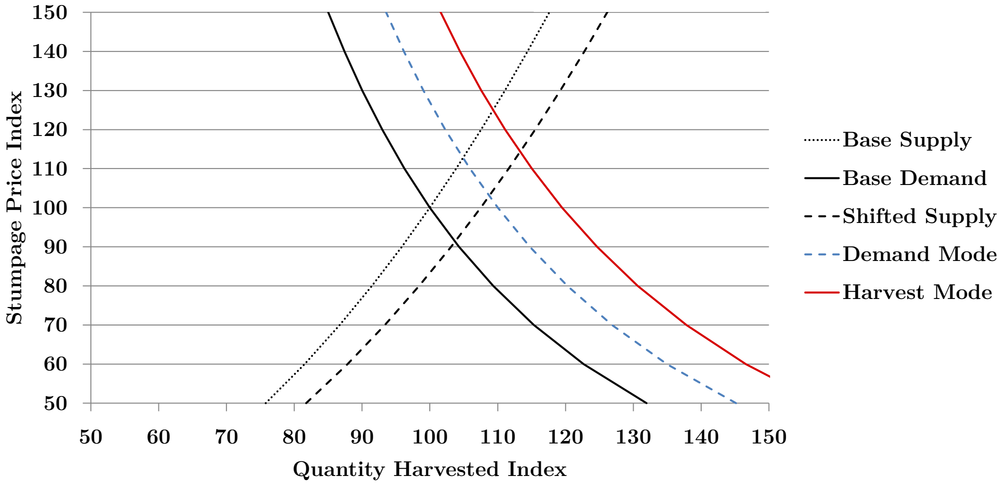
The actual number of counties per basin in a basin request is typically more like twenty or more. Furthermore, the state and county lists should represent a contiguous area. For example, some users use external tools to determine which counties lie within a certain distance from a point of interest. For small basins (e.g. less than 5 counties) we recommend using "one owner" mode, since the USFS is very sensitive to disclosure of ownership data.

1.6 Modeling Options

1.6.1 DRIVER options

Default: *Demand*

Three model driver options are available: harvest mode, demand mode, and price mode. In harvest mode, the path of removals specified in the projection (PRJ) file is followed exactly. SRTS shifts the demand curve in order to obtain the requested harvest. In demand mode the PRJ file tells the model how far to shift the demand curve itself. The difference is illustrated in the figure below. Price mode is equivalent to the harvest mode, except the PRJ file is interpreted as an explicit pathway of prices.



1.6.2 Biomass Options

Depending on the application, scenarios exploring the use of biomass can use built-in biomass options or simply use different DAT files that reference a baseline custom PRJ file and a custom PRJ file that adds biomass to the projection.

- **No Options Checked**–*default*: Demand is based only on the PRJ file.
- **Biomass**: If this box is checked the model read a biomass demand file. This biomass demand file has the same filename as the DAT file but with a ".BM" extension. The format of the biomass file is:

```
"su_logging_09.dat"
Year     BioDemand    PNPCT    PNUTIL  HWUTIL
2010     0     0     0     0
2011     0     0     0     0
2012     0     0     0     0
2013     660000   20   5    5
2014     1320000  20   5    5
2015     1320000  20   5    5
2016     1320000  20   5    5
2017     1320000  20   5    5
2018     1320000  20   5    5
2019     1320000  20   5    5
2020     1320000  20   5    5
```

The first line of the file specifies the source of the logging residue coefficients by survey unit. This file is based on TPO removal and utilization studies adjusted for stumps. The second line is a descriptor line and is not read. For each year (column 1), a biomass demand (column 2, green tons) is specified. Column three specifies the percentage of the biomass that should come from pine feedstock. Note that "99" is interpreted as a code to use the current pulpwood harvest split between species including consideration of logging residues. A "50" in this column would imply a 50/50 split. The next two columns specify the maximum percentage of logging residues that are assumed to offset biomass demand. In this case 15% of both pine and hardwood logging residues are assumed to offset biomass demand. Biomass demand NOT offset by logging residues are assumed to add to pulpwood demand. Use of the biomass option requires use of an Excel template to compare with and without biomass demand runs including market impacts, residue utilization, displacement/leakage, etc.

- **BioBatch**: This is a custom programming option that allows whole sets of DAT files to be run in batch mode. Contact Bob Abt for details.
- **Rwd Bio Dem Split**: If this box is checked and the model is determining the species split (PNPCT=99), the model bases the split only on the roundwood species split and does not adjust the percentage based on residue availability.

1.6.3 Merch Age 10 PP

Default: *On*

If this box is checked then volume in the 10-15 age class are merchandized in terms of removals and inventory. This increases pulpwood volume more that removals but allow better modeling of first thinnings.

1.6.4 Calibrate Growth – *Calibrate GRW*

Default: *On*

There are two growth columns in the .INV file. The CELLGPA column shows the growth per acre actually found in the FIA data. The REGGPA column shows the results of a growth regression that uses data by state, physiographic region (coastal plain, piedmont, mountain, delta), management type and owner to develop a smooth growth curve for the model to use.

Growth calibration calculates the mean growth in pine plantations for ages 15 to 30 for both cell and regression estimates. The regression estimates are then moved up such that the mean of the regression growth is equal to the mean of the cell growth for these ages. This calibrates the smoothed growth curve to match the levels seen in the local data. Growth calibration is implemented unless this option is turned off.

1.6.5 Oth Removals

Default: *On*

The INV file now contains columns of removals, landuse removals, and other removals. Removals are harvests from land that remains in timberland, landuse removals are removals from land that does not remain in timberland, other removals are land that moves into a category where harvest is restricted (e.g. conservation easement). When this box is checked, landuse removals are added to removals in SRTS. Other removals are not considered part of removals in SRTS.

1.6.6 Dynamic Cull Factor – *Dynamic Cull*

Default: *Off*

This option creates a dynamic cull factor which allows the cull factor from product 2 to product 1 to change over time in relation to the change in price ratio. In a standard four product run, this option would increase the cull from pine sawtimber to pine pulpwood in response to pine pulpwood prices increasing relative to pine sawtimber prices.

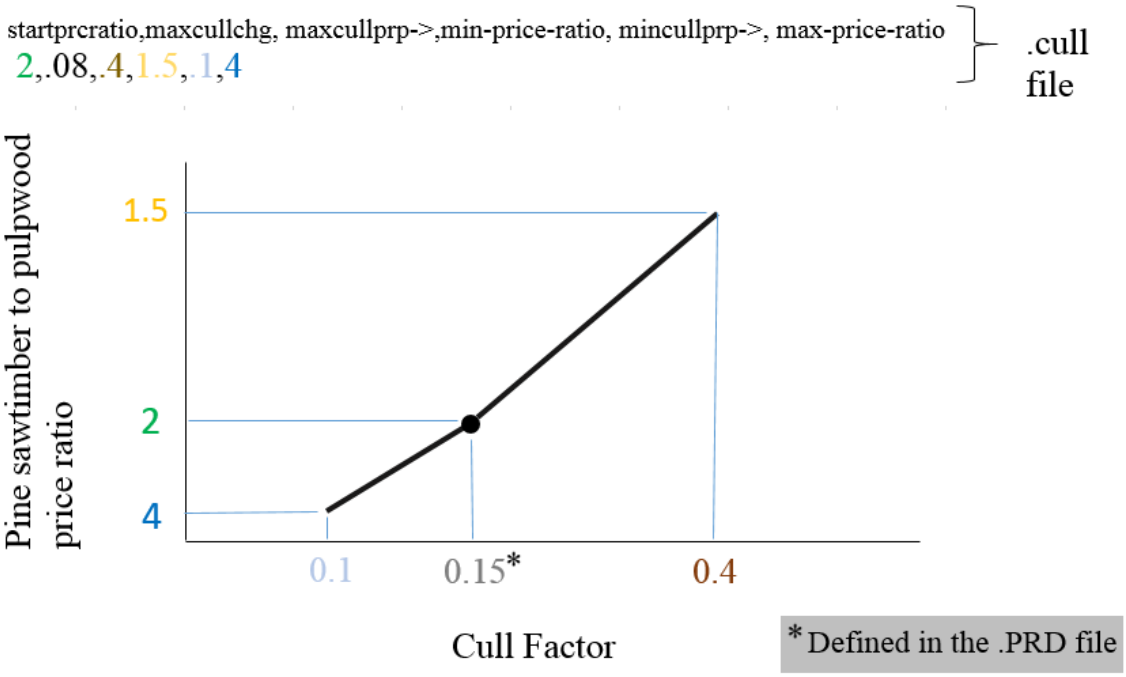
This option requires a ".cull" file which matches the name of the DAT file. The file has six parameters in comma delimited format.

1. The beginning price ratio of product 2 to product 1 (e.g. sawtimber to pulp).

2. The maximum amount the cull factor can change in a given year. This parameter simulates gradual adjustment and prevents the model from oscillating between extremes.
3. The maximum cull proportion of product 2 to product 1. This number should be larger than the cull factor specified in the PRD file (which is the cull factor the model will start with), and it should be less than 1.
4. The minimum price ratio of product 2 to 1.
5. The minimum cull proportion of product 2 to 1.
6. The maximum price ratio of product 2 to 1.

An example format is the following. It can be copied and pasted into a text editor and saved as a ".cull" file:
startprcratio,maxcullchg, maxcullprp-¿,min-price-ratio, mincullprp-¿, max-price-ratio
2,.08,.4,1.5,.1,4

The following figure shows graphically how the numbers in the cull file are related:



1.6.7 Supply Shift Factor File – **.sf*

By default SRTS assumes that demand is mobile and that the market efficiently allocates demand to regions in which supply is increasing. Inventory growth in certain sub-regions may lead to increased removals in that region. If users deem this dynamic to be unreasonable based on knowledge of the region, this effect can be dampened with the supply shift factor option.

```
Product,Region,Owner,DemFctr,SupFctr
1,7,1,1,1
2,1,1,1,0.5
3,7,1,1,0.5
4,4,1,1,0.4
```

The above file dampens the supply shift of products 2-4, corporate owners in regions 1, 7, 4 in the DAT file order. The first line should not be necessary since the default is "1"

1.6.8 Pinemap Growth – *PMAP Growth*

Default: *On*

Data from 20 climate models, in addition to biometric data from the PINEMAP project were incorporated into the Physiological Processes Predicting Growth 3-PG model. The model simulated growth across the historic range of southern yellow pine, growing trees for each planting year between 1971 and 2099, and ending in 2099. County level data was then supplied to us, which we aggregated to survey units and across climate models using regression techniques.

The PMAP Growth option in the latest SRTS version accesses the table of regression coefficients, normalizes the growth to the empirical growth determined by the FIA data, and applies future growth increases in the PINEMAP growth data to the forest inventory. These growth increases vary by planting year, annual age, and FIA survey unit. Selecting this option will apply this growth forecast to the forest inventory.

1.6.9 Dynamic Supply Elasticity – **.de (beta)*

This option was developed for work on a Southern Forest Futures project. It currently works for a four product run only and allows the user to specify a supply elasticity by year for each product. This option requires a *.de file of the following form:

```
A2
2007	0.1 0.18	0.1 0.3
2008	0.1 0.18	0.1 0.3
2009	0.1 0.18	0.1 0.3
2010	0.1 0.18	0.1 0.3
2011	0.095	0.18	0.115	0.32
2012	0.09	0.18	0.13	0.34
2013	0.085	0.18	0.145	0.36
2014	0.08	0.18	0.16	0.38
2015	0.075	0.18	0.175	0.4
2016	0.07	0.18	0.19	0.42
2017	0.065	0.18	0.205	0.44
2018	0.06	0.18	0.22	0.46
```

1.6.10 Product Weights

Default: *Off*

After solving for the equilibrium allocation of all products in a region owner, the model uses a goal program to allocate harvest across management types and age classes. The program attempts to meet the new harvest request while maintaining historical harvest patterns. If it can't it relaxes the historical harvest pattern constraint. The goal program is set up with an equal incentive to hit all product requests. If the inventory is significantly depleted (¿30%) it will likely miss harvest requests. The harvest in the gpg file is the harvest request. If less than 95% of requested harvest is obtained in any year, region, or owner the "CHECK HVMISS FILE" is flagged. This file shows the difference between the request and actual harvest.

If the user wants the program to put a higher priority on meeting the request for one product, the user can change the product weights. Specifying this option requires the presence of an additional file in the model folder. This file must have the same name as the DAT file, but with a .pw extension (e.g. south26.pw). The format of this file is:

```
Prod Goal Wgt Relative to Other Products Format - Prod, Wgt
1 1000
```

In this example, missing product 1 (based on the order in the .PRD file) harvest request will be penalized 1000 times more than other products.

1.6.11 Harvest Location – *.DC

Default: *On–Advanced*

This option allows the user to increase or decrease demand or harvest by product in specific regions. In contrast, by default the model moves harvest among regions and owners based on supply and demand. In order to simulate production increases or decreases in specific regions in a specific year, the economic solution – where demand is satisfied at whatever location is optimal – must be bypassed for that year. After the model finds an optimal solution, in any year where the harvest location option applies, specified harvest in select regions are applied over and above the optimal solution. Regions not specified in the file are held constant for that year.

Specifying this option requires the presence of an additional file in the Input folder. This *direct change* file must have the same name as the DAT file, but with a DC extension (e.g. south16_3.DC). The DC file is formatted with a column for: (1) the year, (2) an index corresponding to regions based on the order of their appearance in the DAT file (DAT number, not the SRTS Region number), and (3) a column for each product listing the increase or decrease in green tons. The top row is a heading row and is ignored as long no year is included. Below is an example in which:

1. The harvest for all four products, in the first four regions listed in the DAT file, are changed for the year 2011.
2. In the year 2017, only the fourth listed region is changed, and only pine and hardwood pulpwood are affected.

The preceding example presents a way to adjust the starting point for the beginning of a run (assuming 2010 is the beginning) and then to bump up pulpwood demand in 2017 for the fourth listed region only.

The DC file in new versions of SRTS automatically adjusts the PRJ file to be consistent with the DC file contents. A custom PRJ can be used in concert with a DC file, but to avoid double-counting, be sure to remember that the contents of these files will effectively be added together.

1.6.12 Partial Harvest – *.ph

This option was developed for the northern version of SRTS. It transforms harvest from an age based classification to a stocking based system. Number of management types and years per age class are all specified along with harvest intensity of partial harvest. The file has the following structure:

```
A2
2007    0.1 0.18    0.1 0.3
2008    0.1 0.18    0.1 0.3
2009    0.1 0.18    0.1 0.3
2010    0.1 0.18    0.1 0.3
2011    0.095   0.18    0.115   0.32
2012    0.09    0.18    0.13    0.34
2013    0.085   0.18    0.145   0.36
2014    0.08    0.18    0.16    0.38
2015    0.075   0.18    0.175   0.4
2016    0.07    0.18    0.19    0.42
2017    0.065   0.18    0.205   0.44
2018    0.06    0.18    0.22    0.46
```

1.6.13 Stocking Target – *.ST

SRTS allocates harvest between thinning and clearcuts based on a stocking (volume per acre) target by owner, forest type, and age class. The default stocking target is the base FIA data from the INV file. One consequence of using starting stocking as the target is that thinning is probably underestimated in early years since most stands are near their target. Checking this option requires an auxiliary file with the same filename as the DAT file but with a ".ST" extension. The format of the file is shown below. The first line is a descriptor line followed by lines that have the manage-type number and the relative stocking target. In the file below the stocking target is set at 50% higher than the base volume per acre for pine plantations, but equal to the base stocking target for other forest types.

```
Stocking Targets by Mgt Type
1 1.5
2 1
3 1
4 1
5 1
```

1.6.14 One Owner

The default option is to model corporate and non-corporate owners separately. Access to these data by county is restricted. Alternatively total private ownership by county is not restricted. Currently we are creating both two-owner and one-owner datasets. In this structure corporate is owner 1, non-corporate is 2, and combined is 3. If the "One Owner" button is checked SRTS runs in one owner mode and screens out anything that is not owner 3. Owner 3 is available in newer DBH distribution files so the same DBH file can be used in two types of runs.

1.6.15 Price Ceiling

Projected prices can often exceed what could realistically be expected. This is especially true in harvest mode. This option allows the user to specify a price ceiling by product. In a harvest driven run, the harvest trend follows the inventory trend after the ceiling is met. In a demand driven run, demand is assumed to be constant after the price ceiling is met. The price ceiling is expressed relative to the year 2 price.

Specifying this option requires the presence of an additional file in the model folder. This file must have the same name as the DAT file, but with a .PC extension (e.g. South33a.PC). The format of this file is:

```
Price Ceiling Relative to Year 2 Price - Format - Prod, Ceiling
1 1.5
```

In this example, product 1 (based on the order in the PRD file) will hit its price ceiling when its price increases by 50 percent.

1.6.16 Pine Plantations Only – *PP Only*

If this option is checked then SRTS only models the pine plantation (Management Type 1) resource. All other parts of the forest base are dropped and all demand must be met from plantations.

1.6.17 Pine Sawtimber Residuals to Pulpwood – *PST Resid to PPW*

Default: *.00*

This modeling option allocates a portion of pine sawmill residual chips to off set pine pulpwood roundwood demand. Valid entries are *.00* to *.99*, but the highest value that should be entered is in the range 0.3 - 0.5. The default proportion is zero. If a non-zero value is entered, that proportion of pine sawtimber harvest increase is assumed to be available as sawmill residual chips to offset pine pulpwood roundwood demand. Only the *increase* above the initial pine sawtimber harvest is included in this calculation. Residual sawmill chips are assumed to already be fully allocated in the start year. To provide an example, entering *.30* means that as pine sawtimber harvest increases, 30 percent of that increase is assumed to offset pine pulpwood demand.

1.7 Landuse Change Options

1.7.1 No Options Checked

The model assumes the total acres by forest type do not change over the projection. Age class distribution changes, but not total acres.

1.7.2 Endog Acre Change

The model uses updated reduced form of results from: Hardie, I.W., P.J. Parks, P.Gottlieb and D. N. Wear. 2000. Responsiveness of rural and urban land uses to land rent determinants in the U.S. South. Land Economics.78 (4): 659-673. These build in loss of rural land from projected population increases. The timberland acres are also sensitive to shifts in rural land between agriculture and forestry. Unless agriculture prices are provided using one of the other land use options, agriculture prices are held constant. Pine pulp and sawtimber prices are used to determine if acres of timberland increase or decrease. Hardwood prices are not part of the rent calculation.

1.7.3 Exog Acre Change

The user specifies the acreage change by forest type in an auxiliary file. The filename must be the same as the DAT filename with an ".AC" extension. The first line of the file is a description line which is not read. The following lines specify the region number followed by the annual percentage acreage change by forest type. Note the region number in this case is based on the order in the region list, NOT the SRTS region number used to link to the dbh distribution. The first region listed is region 1, second is region 2, etc. In the file below region "1" acres are assumed to change as follows: MT1 (plantations) up 1%/year, MT2 (natural pine) down .5% per year, MT3 (mixed pine) down .4% per year, etc.

```
Acre Change Southwide Example File Format- Reg, PctChg Per Year
1 1 -.5 -.4 -.3 -.2
```

1.7.4 Exog Ag Price

The user specifies exogenous ag rent in an auxiliary file "lu_agprc.csv". Contact Bob Abt for details.

1.7.5 PST Only Rent

If this box is checked pine pulpwood prices are excluded from the timberland rent calculation and only pine sawtimber affects interaction with agriculture.

1.7.6 Ag = For Rent

If this box is checked ag rents are assumed to change with forest rents which dampens the forest agriculture land exchange.

1.8 Output Files

1.8.1 The Main Output File – *.GPG

1.8.2 Configuration Settings File (Initialization) – *.INI

1.8.3 Run Description File – *.DSC

The DSC file is a run description file that shows all settings from a model run with the same DAT file name. This file also shows whether the harvest miss file (*.HVMISS) should be checked.

1.8.4 Harvest Miss File – *.HVMISS

After solving for the equilibrium allocation of all products in a region-owner, the model uses a goal program to allocate harvest across management types and age classes. The program attempts to meet the new harvest request while maintaining historical harvest patterns. The goal program is set up with an equal incentive to hit all product requests. If the inventory is significantly depleted (¿30%) it will likely miss harvest requests. The harvest in the gpg file is the harvest request. If less than 95% of requested harvest is obtained in any year, region, or owner the "CHECK HVMISS FILE" is flagged. This file shows the difference between the request and actual harvest. The columns of this file are year, region, and owner, followed by a column for the harvest miss in tons for each product, in the same order as the PRD file.

1.8.5 Harvest Output File – harvout.dat

Fractional changes in inventory, harvest and price by product (Prod Hvst), owner, region, and year.

1.8.6 Growth Adjustment File – *.grwadj

When the Calibrate Growth option is checked (by default), this output file reports the growth factors and adjusted growth per acre resulting from the calibration.

1.8.7 Debug File – *.debug

1.8.8 DBH File – *.DBH

Reports organized in table form for growth, removals and volume by DBH class, management type, owner, region, owner, year and species.

1.8.9 DBH List File – *.DBHLST

Flat file version of the DBH file. Growth, removals and volume by DBH class, management type, owner, region, owner, year and species.

1.8.10 Rent File – *.rent

By year, this file gives indexed pine sawtimber and pine pulpwood prices (PSWPrc and PPWPrc), their respective weights in the rent calculation (PSTWgt and PPWWgt), and indexes for timber and agricultural rent (TbrRent and AgRent).

1.8.11 Land Use File – *.LANDUSE

Gives forest and agricultural land area by region and year.

1.8.12 Age File – *.AGE

Reports organized in table form for acres, volume, growth and removals by age class for each species, year, region, owner and management type.

1.8.13 Acres by Age File – *.ACBYAG

A flat file containing volume, growth, removals and acres by age class, management type, owner, region (and region number), species and year.

1.8.14 Harvest Acres File – *.hvstac

Gives clearcut volume (ClearcutVol), thinned volume (ThinVolume(MCF)), clearcut acres (ClearcutAcres), thinned acres (ThinAcres), and total acres (TotalAcres) by region (Rg), owner (Ow), management type (MT), and age class (AgeCls).

1.8.15 Clearcut Acres File – *.ccacre

Gives acres that have been clearcut (Age0_Acres) by region (Rg), owner, (Ow), management type (MT), and year (Year).

1.8.16 Regional Price Change File – *.rp

In a multi-region run, the model can produce a price output for each region and owner combination, showing how that sub-region alone would react to the demand shift in the PRJ file. This might be useful to rank supply constraints in sub-regions.

The regional price produced is a *spot price* that does not correspond to the actual removals from the region. The actual removals from a region come from assuming that one market-clearing price clears all regional markets.

1.8.17 Dynamic Cull Factor File – *.dcf

When the dynamic cull factor option is employed, this file give the price ratio, cull factor and maximum cull factor change by year.

1.8.18 Linear Program File – lpfile.txt

A printout of the minimized model and constraints. Variable names are abstract.

Chapter 2

Connected Models

2.1 Output Visualization

SRTS produces text and csv file outputs. There are a few methods for visualizing results.

2.1.1 Excel

Some example Excel templates are provided in the documentation folder. Read "outputname.gpg" into Excel, where "outputname" is given in the .DAT file

1. Open as a space delimited file.

2. Copy these data over a pre-existing worksheet with price equations, etc.

3. With the new data selected, sort by RegIdx, OwnIdx,ProdIdx (hidden columns) (or columns B, D, and G in the original datafile)

2.1.2 FigureSRTS

A program that automatically plots SRTS results using R has been developed in a beta stage. We are releasing FigureSRTS with the SRTS distribution. It can be found in the same folder as the SRTS executable. Installation of R is necessary to run the code, and can be downloaded from the r-project website: `https://www.r-project.org/`.

To use the program, first run the SRTS model with a DAT file of your choice. After installation of R (which only needs to be done once), open FigureSRTSBeta. Next, follow the documentation within the code to complete the following necessary steps for setup:

1. Enter the name of your DAT file without the '.DAT' file extension, inside quotes.

2. Enter the year that you want to be your baseline for indexing.

3. Enter a "Y" or "N" based on if you want the figures to include price.

4. Enter a "Y" or "N" based on if you want the include figures and indexed data

5. Enter the file path to the folder where your SRTS executable resides, using double-forward slashes instead of backslashes. One can obtain the file path by clicking on the bar at the top of the Windows Explorer window.

6. Copy and paste this path into FigureSRTS, changing the backslashes to double-forward slashes. Be sure to put a final double-forward slash in the file path.

7. The R installation needs a few more packages in order for the FigureSRTS code to work. Enter a “Y” for the variable FirstTime the first time you run the code. After running this once, you can change it to “N” thereafter.

8. (Optional) If you have named your GPG file using hyphens, underscores or other characters, fill out the optional setup beyond step 6.

9. To run the program, press ‘Ctrl + A’ to select all lines of the code, then hit the symbol at the top left. After running the program, resulting figures and data will appear in the Figures folder, a subfolder of the SRTS 33a folder.

2.1.3 Interpreting and Validating Results

It is possible to successfully run the SRTS model, yet produce output that is unexpected. Here are some rules of thumb that should be observed.

1. If inventory is increasing at a faster rate than removals while demand is constant, prices should go down and vice versa.

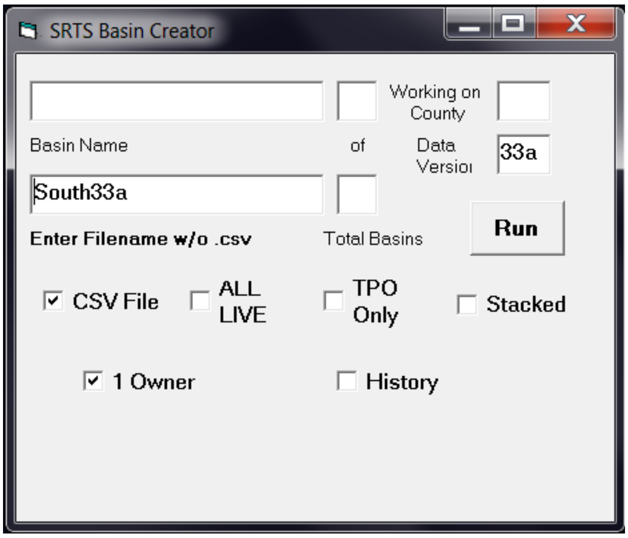
2. If demand is rising and removals are rising, prices may rise, and inventory increases should counteract those price increases.

3. Under smooth demand projections, sharp year-to-year kinks are not typical.

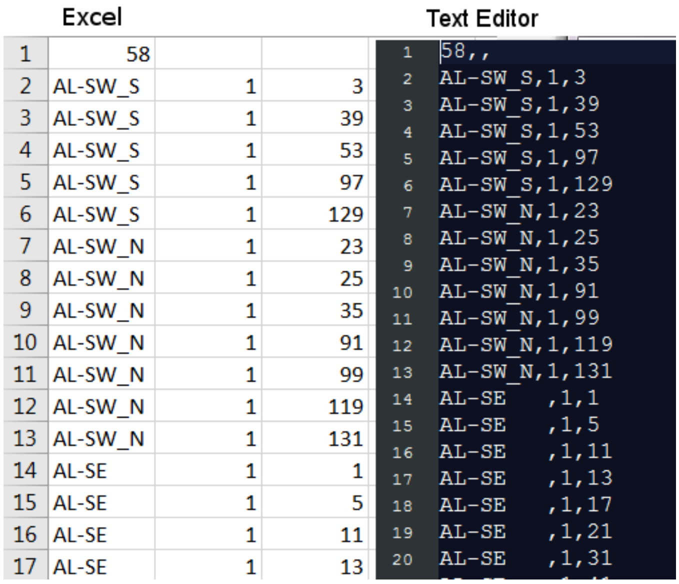
4. If error codes or the ’Check HVMISS’ message are encountered, see the appropriate documentation.

5. Consider using some of the advanced procedures if the model behavior defies expectations.

2.2 INVmaker

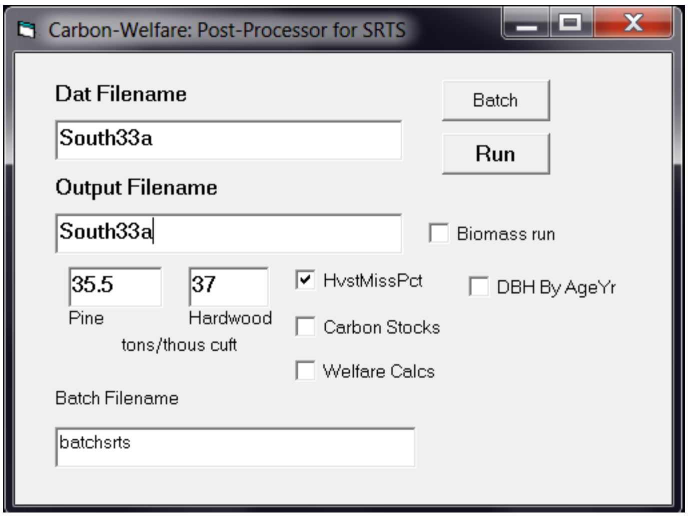


Users have the option to create INV files themselves, which do not differentiate by owner. The INVmaker executable is located in the Data folder. It looks for a basin request file (.csv) with three columns. On the first row and first column, the total number of sub-regions should be designated. Sub-region labels, state FIPS code and county FIPS code should constitute the three columns in the file. The basin request for the entire south, South33a.csv, located in the Data folder, demonstrates the appropriate format of this file. The following is an excerpt of a basin request file, shown in Microsoft Excel and in a text editor:



2.3 Carbon & Welfare

The Carbon-Welfare post-processor uses output files from SRTS to derive economic welfare and carbon pools implied by SRTS run results. To run the program, write the DAT filename and Output filename in the appropriate fields, select the desired output files, and click 'Run'. To run the program for multiple SRTS runs, write the name of a batch file in the 'Batch Filename' field and instead click 'Batch'.



2.3.1 DBH by Age – *.DBHXAGE

From the CarbonWelfare post-processor, selecting the 'DBH By AgeYr' option produces this file. It is a flat file containing growth, volume, acres, removals and acres by DBH class, species, age class, management type, owner, regiona and year.

2.3.2 Carbon by Age – *.CARB_BYAG

From the CarbonWelfare post-processor, selecting the 'Carbon Stocks' option produces this file. By year, region, owner, management type and age class, it gives acres, volume in cubic feet, volume in cubic meters per hectare, hectares, and metric tons for the following carbon pools: live tree, dead tree, understory, down and dead, forest floor and total aboveground carbon. YR,RG,OW,MTYPE,AgeClass,Acres,VolCuFt,m Mg/h

2.3.3 Welfare Analysis File – *.welfare

From the CarbonWelfare post-processor, selecting the 'Welfare Calcs' option produces this file. It gives producer surplus, consumer surplus, price and removals by product, owner, region and year.

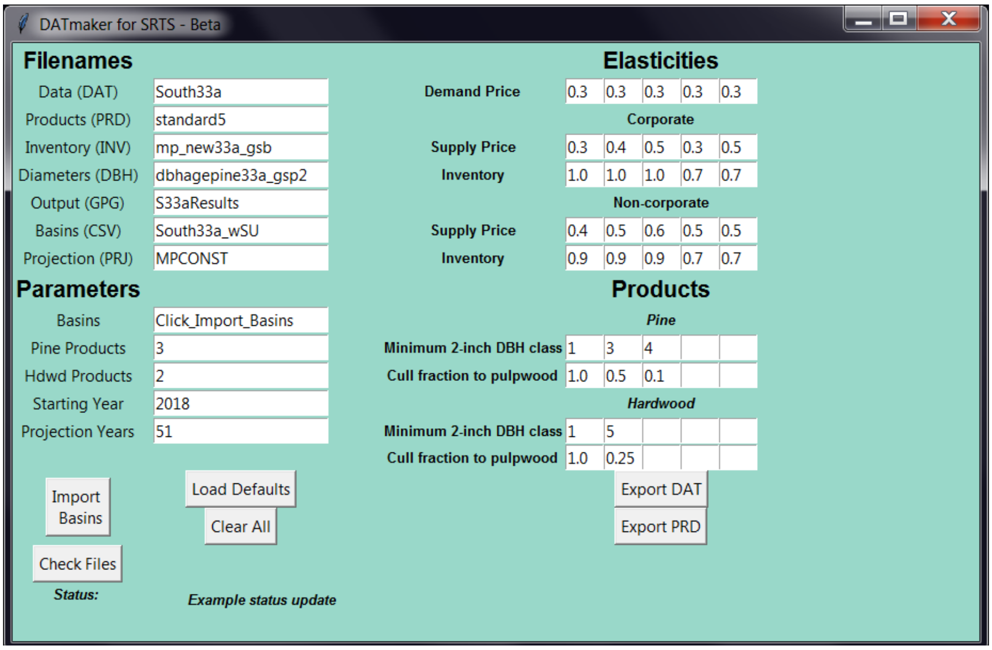
2.4 MapSRTS – *Beta*

An R program used to produce maps of SRTS run results is under development and should be released to members in the 2019-2020 year.

2.5 DATmaker

This standalone executable written in Python is located in the same directory as the SRTS executable. It properly formats DAT files and product (PRD) files, ensuring consistency and placing them in the appropriate location. The program automatically finds the SRTS ecoregion number that corresponds to custom basins.

The default values used by the program are found in the Data folder with a *.default* file type. For advanced users, it is possible to manually alter these files using a text editor.

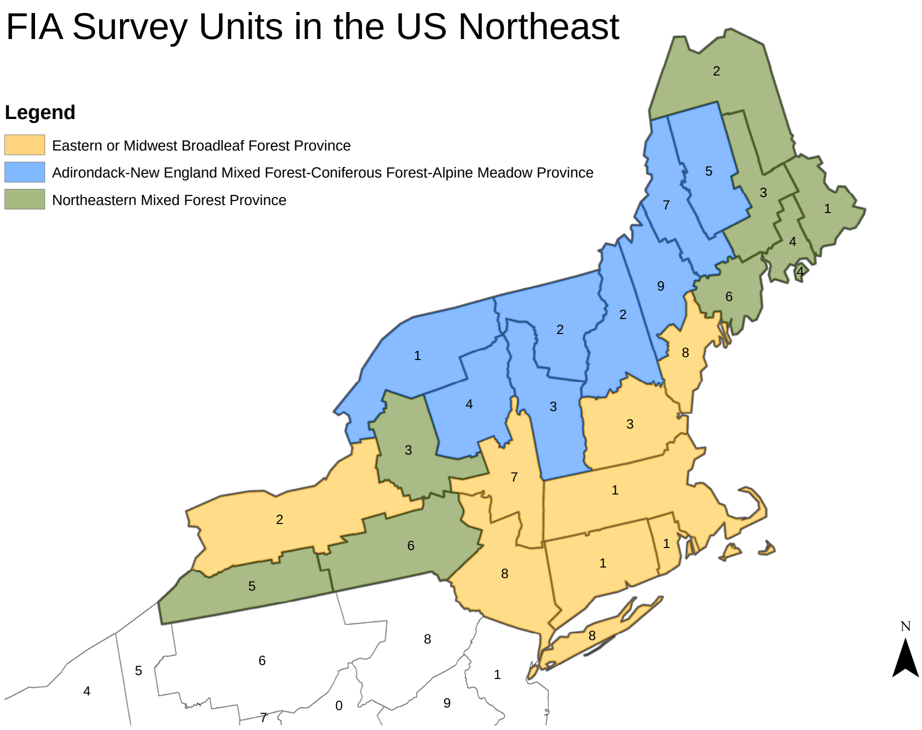


Chapter 3

Extended SRTS Versions

3.1 Northern SRTS

Latest Version - July 2015



Northern SRTS was developed in collaboration with researchers in New Hampshire. It sought to introduce more detail in hardwoods, primarily expressed through partial harvest functionality. This effort contained one hardwood species group category, with 8 management types reflecting more heterogeneity by species.

3.2 Hardwood SRTS

Under Development

A Hardwood SRTS model is being developed to study developing hardwood scarcity issues outside the scope of the standard SRTS model. The following tables show the current proposed species groups, based on a 5% cut-off for species abundance (Table 3.1 and 3.2). Table 3.3 shows forest types, or management types.

Table 3.1: Selected Species Groups for the Hardwood SRTS Study Region

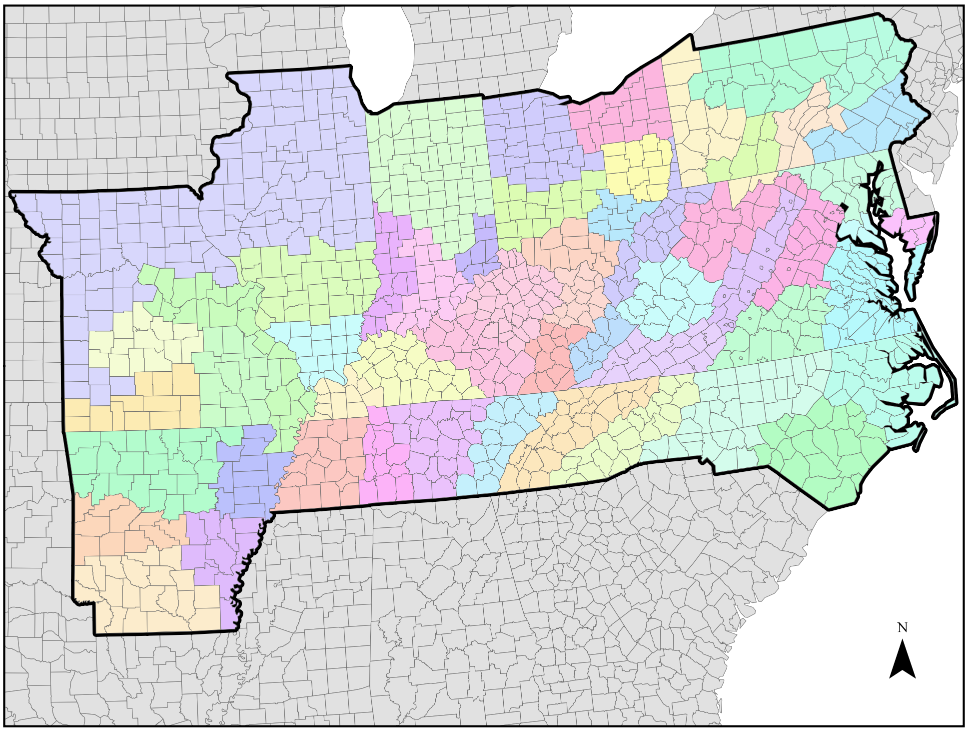
SPGRPCD	SPGRP_NAME	Percent	Species Code	Species Abbrev.
39	Yellow-poplar	12.11	**1**	POP
25	Select white oaks	9.7	**2**	SWO
2	Loblolly and shortleaf pines	9.26	**3**	SYP
28	Other red oaks	8.37	**4**	ORO
32	Soft maple	8.23	**5**	MAP
41	Other eastern soft hardwoods	7.35	**6**	OSH
27	Other white oaks	6.77	**7**	OWO
29	Hickory	6.54	**8**	OHH
26	Select red oaks	5.83	**9**	SRO
31	Hard maple	4.34	8	OHH
36	Ash	3.08	8	OHH
34	Sweetgum	2.56	6	OSH
3	Other yellow pines	2.12	3	SYP
4	Eastern white and red pines	2.05	**10**	CON
42	Other eastern hard hardwoods	2	8	OHH
33	Beech	1.98	8	OHH
35	Tupelo and blackgum	1.62	6	OSH
7	Eastern hemlock	1.26	10	CON
40	Black walnut	1.08	8	OHH
38	Basswood	1	6	OSH
37	Cottonwood and aspen	0.99	6	OSH
9	Other eastern softwoods	0.83	10	CON
1	Longleaf and slash pines	0.29	3	SYP
8	Cypress	0.28	10	CON
30	Yellow birch	0.26	8	OHH
6	Spruce and balsam fir	0.11	10	CON
5	Jack pine	0	10	CON
43	Eastern noncommercial hardwoods	0	6	OSH

Table 3.2: Species Codes, Abbreviations and Descriptions.

Species Code	Species Abbrev.	Species Description
1	POP	Yellow Poplar
2	SWO	Select White Oak
3	SYP	Southern Yellow Pine
4	ORO	Other Red Oaks
5	MAP	Soft Maple
6	OSH	Other Soft Hardwoods
7	OWO	Other White Oak
8	OHH	Other Hard Hardwoods
9	SRO	Select Red Oak
10	CON	Other Softwood, Conifers

Table 3.3: Selected Forest Type Groups for the Hardwood SRTS Study Region

TYPGRPCD	Name
	Oak
500	Oak / hickory group
	Maple & Birch
800	Maple / beech / birch group
900	Aspen / birch group
100	White / red / jack pine group
	Southern Yellow Pine
160	Loblolly / shortleaf pine group
140	Longleaf / slash pine group
	Mixed Oak & Pine
400	Oak / pine group
	Other Softwoods
120	Spruce / fir group
170	Other eastern softwoods group
200	Douglas-fir group
260	Fir / spruce / mountain hemlock group
380	Exotic softwoods group
390	Other softwoods group
	Bottomland & Other Hardwoods
600	Oak / gum / cypress group
700	Elm / ash / cottonwood group
960	Other hardwoods group
990	Exotic hardwoods group



Chapter 4

Technical Documentation

4.1 Economics

The Sub-regional Timber Supply Model (SRTS) is a partial-equilibrium economic model that spatially optimizes timber harvests for a market-wide demand, subject to sub-regional supply curves that reflect price and inventory constraints.

The economic module in SRTS uses constant elasticity supply and demand curves. For each sub-region (i), owner (o), and product (j) in one-year time step (t), the supply function (Q^S) is a function of price (P) and total growing stock inventory (I), parameterized by a price elasticity of supply (γ) and an inventory elasticity (τ) as represented in Equation 1. The model sums sub-regional supply curves to obtain supply market-wide supply (Equation 2). Recursively on an annual time step, the model uses a linear optimization algorithm to produce equilibrium with the market-wide demand (Q^D) curve (Equation 3), parameterized by a price elasticity of demand (ϵ) and an exogenous demand shifter (G).

$$Q^S_{iojt} = \alpha P_t^{\gamma_{oj}} I_{iojt}^{\tau_j} \tag{4.1}$$

$$\sum_{ioj} Q^S_{iojt} = Q^S_t = Q^D_t \tag{4.2}$$

$$Q^D_t = \beta P_t^{\epsilon_j} G_t^{\delta} \tag{4.3}$$

4.2 FIA Summary Procedures

The biology and initial conditions in SRTS derive from summarized Forest Inventory and Analysis (FIA) plot data for growth, inventory and removals for each sub-region, retaining heterogeneous features of ownership (corporate, non-corporate), management type, species, age class, and diameter-at-breast-height (dbh) distributions by physiographic region.

4.3 Merchandising Procedure

Users define products by their diameter-at-breast-height (DBH) measurement in inches in the PRD file. DBH distributions by age class and other dimensions, contained in the DBH file, are combined with growing stock and removals information in the INV file to obtain growing stock and removals by product in each age class by species, ownership, and management type.

4.4 Advanced Options

4.5 SRTS Code

SRTS is currently written in Visual Basic. The logical structure of the model is presented below, organized by module components.

4.5.1 Main – srtsmmddyy.FRM

This form file controls the design and variable inputs from the user interface.

Sub-processes:

1. Command1_Click()
   - Calls MakeHvstPrj()
2. LoadSettings_Click()
   - Loads the *.ini file
3. Form_Load()
   - Loads the setup.id file

4.5.2 GPHARV – gphvstmmddyy.BAS

This module manages harvest calculations.

Sub-processes:

1. GPHVST()
   - Calls the goal program to minimize harvest misses by management type and age class.
2. MakeHvstPrj()
   - Determines removals by product implied by the INV, PRD and DBH files and creates the MPCONST.PRJ file.
3. ProdVolByAC()
   - Calculates product volume by age class, merchandizing through the DBH file.
4. ReadVolByDBH()
   - Reads the DBH file.
5. RedimArrays()
   - Redimension arrays to save memory.
6. ToAnnual()
   - Annualizes removals and volume data from age class data.
   - Makes growth calculations

4.5.3 Module 1 – frontkey.bas

This module simply provides a license key for the linear programming solver.

4.5.4 MPMAIN – mpmainmmddyy.bas

This module declares most variables in the model, simulates biology, and handles particular model behaviors related to user settings.

Sub-processes:

1. ConstantsAndLabels()
2. NewRemovals()
3. OutByDBH()
4. OutRatio()
5. OuttoFile()
6. ProdtPrint()
   - Calls OutToFile, OutByDBH
7. ProjectionLoop()
   - Initiates most output files: harvout.dat, GPG, .AGE", .ACR, .DBH, .ACbyAg, .debug, .DSC, .DBHLST, .landuse, .hvstac, .ccacre, .rent, .dcf
   - Calls other subproceeses: SumAgeClass, ProdtPrint, SRTS, GPHVST, NewRemovals, SumPrint
8. ReadData()
   - Reads the INV file (var = *DataFile*)
   - Creates the *.grwadj file
9. ReadSetupParams()
   - Reads the DAT file
   - Reads Modeling options from the user interface, conditionally looking for supporting files.
10. SRTS()
    - Declares variables and weights for the linear program.
    - Reads in the PRJ file.
    - Sums across sub-regions to obtain total removals by owner, total removals, and total inventory.
    - Calculates percent of total harvest by owner.
    - Imposes market equilibrium constraints and employs an equilibrium price search loop.
    - Prints the GPG file and additional output files.
11. PCutLimit() – deprecated(?)
12. Stocking()
    - Calculates volume per acre by species, region, owner, management type, age class, planting year
13. SumAgeClass()
    - Aggregates annual data age classes
    - Grows inventory volume by age class
14. SumPrint()
    - Prints the harvout.dat file.

4.5.5 SaFrontmip – safrontmip.bas

Declares functions and variables for the linear programming solution. References *Frontmip.DLL*.

Chapter 5

Publications

The following is a list of papers and publications which have used the Sub-Regional Timber Supply (SRTS) model. This section is currently a work in progress and not exhaustive.

Abt, R.C., Abt, K.L., Cubbage, F.W., Henderson, J.D., 2010. Effect of policy-based bioenergy demand on southern timber markets: A case study of North Carolina. Biomass and Bioenergy. https://doi.org/10.1016/j.biombioe.2010.05.007

Abt, R.C., Galik, C.S., Henderson, J.D., 2010. The Near-Term Market and Greenhouse Gas Implications of Forest Biomass Utilization in the Southeastern United States. Durham, NC.

Murray, B.C., Abt, R.C., 2001. Estimating price compensation requirements for eco-certified forestry. Ecol. Econ. 36, 149–163. https://doi.org/10.1016/S0921-8009(00)00224-X

Rossi, F.J., Carter, D.R., Abt, R.C., 2010. Woody Biomass for Electricity Generation in Florida: Bioeconomic Impacts under a Proposed Renewable Portfolio Standard (RPS) Mandate Final Report.

Guo, Z., Hodges, D.G., Abt, R.C., 2011. Forest Biomass Supply for Bioenergy Production and Its Impacts on Roundwood Markets in Tennessee. South. J. Appl. For. 35, 80–86. https://doi.org/10.1093/sjaf/35.2.80

Young, T.M., Hodges, D.G., Abt, R.C., Hartsell, A.J., Perdue, J.H., 2009. Regional Comparative Advantage for Woody Biofuels Production. Final Rep. US DOT Southeast. Sun Grant Center. Univ. Tennessee, Knoxville. 167p. 1–167.

Bingham, M.F.., Prestemon, J.P.., MacNair, D.J.., Abt, R.C.., 2003. Market structure in U.S. southern pine roundwood. J. For. Econ. 9, 97–117. https://doi.org/10.1078/1104-6899-00025

EPA, 2014. Revised framework for assessing biogenic CO2 from stationary sources.

Duden, A.S., Verweij, P.A., Junginger, H.M., Abt, R.C., Henderson, J.D., Dale, V.H., Kline, K.L., Karssenberg, D., Verstegen, J.A., Faaij, A.P.C., van der Hilst, F., 2017. Modeling the impacts of wood pellet demand on forest dynamics in southeastern United States. Biofuels, Bioprod. Biorefining. https://doi.org/10.1002/bbb.1803

Galik, C.S., Abt, R.C., Latta, G., Méley, A., Henderson, J.D., 2016. Meeting renewable energy and land use objectives through public-private biomass supply partnerships. Appl. Energy. https://doi.org/10.1016/j.apenergy.2016.03.047

Galik, C.S., Abt, R.C., 2016. Sustainability guidelines and forest market response: an assessment of European Union pellet demand in the southeastern United States. GCB Bioenergy 8, 658–669. https://doi.org/10.1111/gcbb.12273

Pattanayak, S.K., Abt, R.C., Sommer, A.J., Cubbage, F., Murray, B.C., Yang, J.C., Wear, D., Ahn, S.E., 2004. Forest forecasts: Does individual heterogeneity matter for market and landscape outcomes? For. Policy Econ. 6, 243–260. https://doi.org/10.1016/j.forpol.2004.03.017

Rafal, C., Abt, R.C., Jonsson, R., Prestemon, J.P., Cubbage, F.W., 2013. Modeling the Impacts of EU Bioenergy Demand on the Forest Sector of the Southeast U.S. J. Energy Power Eng. 7, 1073–1081.

Galik, C.S., Abt, R.C., Latta, G., Vegh, T., 2015. The environmental and economic effects of regional bioenergy policy in the southeastern U.S. Energy Policy 85, 335–346. https://doi.org/10.1016/J.ENPOL.2015.05.018

Guo, Z., Hodges, D.G., Abt, R.C., n.d. Supply for Bioenergy Production in Tennessee Forest Biomass Supply for Bioenergy Production in Tennessee.